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Radio Resource Management Using Geometric Water-Filling

Springer

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Preface

Radio resource management (RRM) has been an important task for wireless communication systems. With the emergence of more advanced and more complicated systems, such as cognitive radio, nodes with energy harvest capacities (green communications), and the application of multiple-input multiple-output (MIMO) technology, RRM encounters more difficulties and challenges to optimize system performances. Due to the specific structure of communication systems, water-filling (WF) plays an important role in RRM. This book introduces the fundamental theory and development of WF algorithms. A geometric water-filling (GWF) approach is presented and compared with the conventional WF algorithms. It is shown that GWF provides more insights into solutions and problems. It can break through the limitations of the conventional WF to solve more complicated optimization problems. The applications of the proposed GWF to solve RRM problems in advanced communication systems, e.g., multiple-input multiple-output communication systems, cognitive radio communication systems, and green communication systems, are investigated in this book. Efficient algorithms are presented to achieve optimal resource allocation. Since the authors are active in RRM research, some of their recently published results, as the above-mentioned effective algorithms, are presented in this book. The book addresses important emerging topics in RRM of wireless system design in more detail. No system design is possible without understanding the underlying channels, therefore Chap. 1 focuses on this topic. Many modern radio resource systems use water-filling as the underlying tool. Chapter 2 discusses this important technology in great detail. RRMs of both single-user and multi-user cases, and optimality of the RRM issues in system design, are presented in Chap. 3 for the MIMO system. Chapter 4 considers the scheduling problem under the cognitive radio (CR) network, i.e., allocation of resources to multiple users in a wireless system under CR network, an issue of critical importance in a multi-user system. Chapter 5 considers the optimal design of RRM in harvested energy in order to achieve maximum throughput, for green communications. Every chapter offers examples in a separate section, which unfolds the potential power of developing water-filling.

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Contents

Acronyms

$A(\cdot)$	Mapping
$\mathbb{C}(H,P)$	Channel capacity
$\mathbb{C}^n$	Unitary space with dimension n
$\mathbb{C}^{m\times n}$	Set of $m \times n$ complex matrices
$\det(B)$ or $\lvert B\rvert$	Determinant of the square matrix B
$\mathrm{E}(\xi)$	Expected value of the random variable ξ
f_ξ	Probability density function of random variable ξ
H	Channel matrix
$H^\dagger$	Conjugate transpose of matrix H
$H_i^\dagger$	Conjugate transpose of matrix H_i
H_i^T	Transpose of matrix H_i
$\mathbb{H}(\xi)$	Differential entropy
$\mathbb{H}(\xi\mid\eta)$	Conditional entropy
I_r	Identity matrix with dimension r
$\mathbb{I}(\xi;\eta)$	Mutual information
log	Natural logarithm
$\mathrm{M}\succeq 0$	Matrix M being positive semi-definite
$\mathrm{Tr}(M)$	Trace of matrix M
$\lfloor\ \rfloor$	Floor function
$\lceil\ \rceil$	Ceiling function
KKT	Karush-Kuhn-Tucker
WFA	Water-filling algorithm
IWFA	Iterative water-filling algorithm
MIMO	Multiple input multiple output
MAC	Multiple access channel
BC	Broadcast channel
CR	Cognitive radio
EH	Energy harvest
GWF	Geometric water-filling