

The copyright © of this thesis belongs to its rightful author and/or other copyright owner. Copies can be accessed and downloaded for non-commercial or learning purposes without any charge and permission. The thesis cannot be reproduced or quoted as a whole without the permission from its rightful owner. No alteration or changes in format is allowed without permission from its rightful owner.

**RESOURCE ALLOCATION TECHNIQUE FOR POWERLINE  
NETWORK USING A MODIFIED SHUFFLED FROG-LEAPING  
ALGORITHM**

**ABDALLAH MAHMOUD MOUSA ALTRAD**

**DOCTOR OF PHILOSOPHY  
UNIVERSITI UTARA MALAYSIA  
2018**



Awang Had Salleh  
Graduate School  
of Arts And Sciences

Universiti Utara Malaysia

**PERAKUAN KERJA TESIS / DISERTASI**  
(Certification of thesis / dissertation)

Kami, yang bertandatangan, memperakukan bahawa  
(We, the undersigned, certify that)

**ABDALLAH MAHMOUD MOUSA ALTRAD**

calon untuk Ijazah

**PhD**

(candidate for the degree of)

telah mengemukakan tesis / disertasi yang bertajuk:  
(has presented his/her thesis / dissertation of the following title):

**"RESOURCE ALLOCATION TECHNIQUES FOR POWERLINE NETWORK USING A MODIFIED  
SHUFFLED FROG-LEAPING ALGORITHM"**

seperti yang tercatat di muka surat tajuk dan kulit tesis / disertasi.  
(as it appears on the title page and front cover of the thesis / dissertation).

Bahawa tesis/disertasi tersebut boleh diterima dari segi bentuk serta kandungan dan meliputi bidang ilmu dengan memuaskan, sebagaimana yang ditunjukkan oleh calon dalam ujian lisan yang diadakan pada : **27 September 2017**.

*That the said thesis/dissertation is acceptable in form and content and displays a satisfactory knowledge of the field of study as demonstrated by the candidate through an oral examination held on: September 27, 2017.*

Pengerusi Viva:  
(Chairman for VIVA)

Prof. Dr. Norshuhada Shiratuddin

Tandatangan  
(Signature)

Pemeriksa Luar:  
(External Examiner)

Assoc. Prof. Dr. Abas Md Said

Tandatangan  
(Signature)

Pemeriksa Dalam:  
(Internal Examiner)

Assoc. Prof. Dr. Osman Ghazali

Tandatangan  
(Signature)

Nama Penyelia/Penyelia-penyelia:  
(Name of Supervisor/Supervisors)

Prof. Dr. Wan Rozaini Sheik Osman

Tandatangan  
(Signature)

Nama Penyelia/Penyelia-penyelia:  
(Name of Supervisor/Supervisors)

Assoc. Prof. Dr. Angela Amphawan

Tandatangan  
(Signature)

Tarikh:

(Date) **September 27, 2017**

## **Permission to Use**

In presenting this thesis in fulfilment of the requirements for a postgraduate degree from Universiti Utara Malaysia, I agree that the Universiti Library may make it freely available for inspection. I further agree that permission for the copying of this thesis in any manner, in whole or in part, for scholarly purpose may be granted by my supervisor(s) or, in their absence, by the Dean of Awang Had Salleh Graduate School of Arts and Sciences. It is understood that any copying, publication, or use of this thesis or parts thereof for financial gain shall not be allowed without my written permission. It is also understood that due recognition shall be given to me and to Universiti Utara Malaysia for any scholarly use which may be made of any material from my thesis.

Requests for permission to copy or to make other use of materials in this thesis, in whole or in part, should be addressed to:

Dean of Awang Had Salleh Graduate School of Arts and Sciences

UUM College of Arts and Sciences

Universiti Utara Malaysia

06010 UUM Sintok

## Abstrak

Teknik peruntukan sumber patut dijadikan lebih efisien dan dioptimalkan untuk meningkatkan Kualiti Perkhidmatan (kuasa dan bit, kapasiti, keboleh-skala) bagi aplikasi jaringan data berkelajuan tinggi. Kajian ini cuba meningkatkan lagi kecekapan menuju prestasi hampir optima. Masalah peruntukan sumber merangkumi pemilihan penguntukan subpembawa, penentuan kuasa dan bit penghantaran bagi setiap subpembawa. Beberapa kajian yang dijalankan oleh Suruhanjaya Komunikasi Persekutuan telah membuktikan bahawa pendekatan peruntukan spektrum konvensional semakin tidak mencukupi dalam menangani kehendak pesat spektrum jaringan, yang mana ini menyebabkan ketidakcekapan dalam penggunaan spectrum, kapasiti dan penumpuan rendah, prestasi rendah kadar kesilapan bit, kelewatan maklumbalas saluran, keboleh-skala lemah serta kerumitan pengiraan membuat penyelesaian masa nyata sukar dikawal. Terutamanya ini adalah disebabkan oleh kekangan yang canggih, ketat, berbilang objektif, tidak adil, saluran bising, juga tidak realistik apabila menganggap saluran yang sesuai boleh didapati. Tujuan utama kajian ini adalah untuk membangunkan satu rangka kerja konseptual dan model matematik untuk peruntukan sumber menggunakan Algoritma Menyusun Semula Lompat Katak (SFLA). Justeru, satu SFLA yang diubahsuai untuk kuasa optimum, bit, dan teknik-teknik peruntukan subpembawa telah diperkenalkan dan disepadukan ke dalam sistem OFDM. Populasi penyelesaian yang dijanakan SFLA secara rawak (kuasa, bit), dimana ketepatan setiap penyelesaian dihitung dan ditingkatkan untuk setiap subpembawa dan pengguna. Kemudian, penyelesaian disahkan dan dijamin-pasti secara numerik dengan menggunakan saluran jaluran kuasa berasaskan simulasi. Prestasi sistem telah dibandingkan dengan kajian yang serupanya dari segi kapasiti, keboleh-skala, kadar/kuasa yang diperuntukkan dan penumpuan sistem. Peruntukan sumber sentiasa dioptimalkan and kapasiti yang diperolehi adalah lebih tinggi secara malar berbanding dengan algoritma Mencari Punca, Linear dan evolusi Hibrid. Algoritma yang dicadangkan ini mampu menjana kapasiti yang tinggi serta penumpuan yang paling cepat memandangkan jumlah lelaran yang diperlukan untuk mencapai 0.001% ralat optimum global ialah 75 berbanding dengan 92 dalam teknik konvensional. Akhir sekali, model peruntukan untuk pemilihan optima nilai sumber diperkenalkan: kuasa adaptif dan peruntukan bit dalam OFDM berasaskan sistem jaluran kuasa dan modifikasi TLBO dan PSO berasaskan SFLA dicadangkan.

**Kata Kunci:** Jaluran kuasa, Pemultipleksan Pembahagian Frekuensi Ortogon (OFDM), Peruntukan Sumber, Menyusun Semula Lompat Katak (SFLA).

## Abstract

Resource allocation (RA) techniques should be made efficient and optimized in order to enhance the QoS (power & bit, capacity, scalability) of high-speed networking data applications. This research attempts to further increase the efficiency towards near-optimal performance. RA's problem involves assignment of subcarriers, power and bit amounts for each user efficiently. Several studies conducted by the Federal Communication Commission have proven that conventional RA approaches are becoming insufficient for rapid demand in networking resulted in spectrum underutilization, low capacity and convergence, also low performance of bit error rate, delay of channel feedback, weak scalability as well as computational complexity make real-time solutions intractable. Mainly due to sophisticated, restrictive constraints, multi-objectives, unfairness, channel noise, also unrealistic when assume perfect channel state is available. The main goal of this work is to develop a conceptual framework and mathematical model for resource allocation using Shuffled Frog-Leap Algorithm (SFLA). Thus, a modified SFLA is introduced and integrated in Orthogonal Frequency Division Multiplexing (OFDM) system. Then SFLA generated random population of solutions (power, bit), the fitness of each solution is calculated and improved for each subcarrier and user. The solution is numerically validated and verified by simulation-based powerline channel. The system performance was compared to similar research works in terms of the system's capacity, scalability, allocated rate/power, and convergence. The resources allocated are constantly optimized and the capacity obtained is constantly higher as compared to Root-finding, Linear, and Hybrid evolutionary algorithms. The proposed algorithm managed to offer fastest convergence given that the number of iterations required to get to the 0.001% error of the global optimum is 75 compared to 92 in the conventional techniques. Finally, joint allocation models for selection of optima resource values are introduced; adaptive power and bit allocators in OFDM system-based Powerline and using modified SFLA-based TLBO and PSO are proposed.

**Keywords:** Powerline, Orthogonal Frequency Division Multiplexing, Systems Performance, Shuffled Frog-Leap Algorithm.

## Declaration

Some of the work presented in this thesis has published as listed below.

- [1] Osman, S., & Nisar, K., & Altrad, M. (2012). ICT rural area model for broadband technology over power lines network. 3<sup>rd</sup> International Computer on Network Application Protocols and Services (NetApps).
- [2] Osman, S., Nisar, K., & Altrad, M. (2012). Modelling of remote area broadband technology over low voltage power line channel. International Journal of Computer Networks & Communications (IJCNC).
- [3] Osman, S., Nisar, K., & Altrad, M. (2012). Initial model based Malaysia Regulations Broadband Technology over Power Line Networks. Knowledge Management International Conference (KMICe), Johor, Bahru, Malaysia, 433-436.
- [4] Osman, S., Nisar, K., & Altrad, M. (2013). Characterizing Broadband over Low Voltage Power Line Network in Malaysia. Rural ICT Development (RICTD) International Conference 2013, Melaka: MALAYSIA.
- [5] Nisar, K., Osman, S. & Altrad, M. (2014). Modelling of Broadband over Indoor Power Line Network in Malaysia. The 10<sup>th</sup> International Conference on Computing and Information Technology (IC2IT). Published in Springer. Phuket, Thailand.
- [6] Osman, S., Nisar, K., & Altrad, M. (2014). Viability of Broadband Access over Residential Power Line Communication Network. IEEE, In the 2<sup>nd</sup> International Conference on Electronic Design (ICED). Penang: Malaysia.
- [7] Altrad, M.M. Abdullah., Angela Amphwan., & Osman, S. (2017). A Joint Resource Allocation Technique in OFDM System for Powerline Network. Wiley Transactions on Emerging Telecommunications. *Accepted with correction.*
- [8] Angela Amphwan, Osman, S., & Altrad, M.M. Abdullah (2017). Adaptive Power Resource Allocation Technique for Powerline Channel Based A Modified Shuffled Frog-Leap Algorithm. Wiley Transactions on Emerging Telecommunications. *Accepted with correction.*
- [9] Altrad, M.M. Abdullah., Angela Amphwan., & Osman, S. (2017). Adaptive Subcarrier and Bit Resource Allocation Technique for Powerline Channel Based A Modified Shuffled Frog-Leap Algorithm. Wiley Transactions on Emerging Telecommunications. *Accepted with correction.*

## **Acknowledgement**

First and foremost, I would like to thank ALLAH the Almighty, who blessed me with the power, courage and the intellectual ability to complete this research work. I would like to express my special appreciation to my parents, and siblings for their unflinching support and encouragement.

I have the honour to express my sincere gratitude to my main supervisor, Professor Dr Wan Rozaini Bt Sheik Osman, for putting me on this research track and for her enduring professional guidance throughout my research work. I am also grateful to my co-supervisors Professor Dr Angela Amphawan for their help, guidance and solid scientific supervision. Without their help, the achievements in my research would never be possible.

I would also like to express my utmost gratitude to Universiti Utara Malaysia for supporting this work. True regards and admiration to all friends and colleagues in UUM who have truly proven their friendship encouragement and support.



## Table of Contents

Permission to Use .....	i
Abstrak.....	ii
Abstract.....	iii
Declaration.....	iv
Acknowledgement .....	v
Table of Contents.....	vi
List of Tables .....	ix
List of Figures.....	x
List of Abbreviations .....	xi
<b>CHAPTER ONE INTRODUCTION .....</b>	<b>1</b>
1.1 Background of the Study.....	1
1.2 Research Motivation .....	7
1.3 Problem Statement .....	9
1.4 Research Objectives .....	10
1.5 Research Scope .....	10
1.6 Research Strategy.....	11
1.7 Research Framework.....	12
1.8 Research Contributions .....	13
1.9 Thesis Organisation.....	14
<b>CHAPTER TWO LITERATURE REVIEW .....</b>	<b>16</b>
2.1 Power Line Communication (PLC) .....	16
2.1.1 PLC Channel Transfer Function .....	20
2.2 Orthogonal Frequency Division Multiplexing (OFDM).....	24
2.3 Resource Allocation Techniques in OFDM.....	27
2.3.1 Water-Filling Solution .....	33
2.3.2 Maximization and Minimum Fairness Criterion.....	35
2.3.3 Weighted Fairness.....	36
2.3.4 Utility Maximization.....	37
2.3.5 Cross Layer Optimization .....	39
2.3.6 Resource Allocation Based Game Theory .....	40

2.3.7 Non-cooperative Solutions.....	42
2.3.8 Cooperative Solutions .....	43
2.4 Resource Allocation Techniques in Powerline Network .....	45
2.5 Shuffled Frog-Leap Optimization Algorithm .....	50
2.6 Research Gap .....	67
2.7 Chapter Summary.....	68
<b>CHAPTER THREE RESEARCH METHODOLOGY .....</b>	<b>69</b>
3.1 Research Methodology.....	69
3.1.1 Critique Phase .....	71
3.1.2 Design Phase .....	71
3.1.3 Implementation Phase .....	72
3.1.4 Evaluation Phase .....	72
3.2 Network Evaluation Techniques .....	73
3.2.1 Analytical Modelling .....	73
3.2.2 Measurement.....	74
3.2.3 Simulation .....	74
3.3 Simulation Tool.....	75
3.4 Performance Metrics .....	76
3.5 Resource Allocation .....	77
3.6 Powerline Channel Model.....	78
3.7 Chapter Summary.....	81
<b>CHAPTER FOUR EFFICIENT POWER ALLOCATION TECHNIQUE .....</b>	<b>82</b>
4.1 Allocation System Model.....	82
4.1.1 Number of Bit and Subcarriers per User.....	88
4.1.2 Power per Subcarrier.....	91
4.1.3 SFLA for Power per User .....	91
4.2 Implementation of Simulation .....	93
4.2.1 Comparison's Result.....	96
4.2.2 Simulation's Results .....	98
4.3 Modified SFLA Based TLBO .....	103
4.3.1 Analytical and Numerical Analysis .....	111

4.3.2 Result of the Modified SFLA Based TLBO .....	114
4.4 Chapter Summary.....	118
<b>CHAPTER FIVE EFFICIENT RATE ALLOCATION TECHNIQUE.....</b>	<b>120</b>
5.1 Allocation System Model.....	120
5.1.1 Power per User.....	121
5.1.2 Subcarrier Allocation .....	122
5.1.3 Bit Allocation.....	125
5.2 System's Result of the Adaptive Model.....	127
5.2.1 Bit Rate of each User .....	127
5.2.2 Channel Gain of each User .....	127
5.2.3 Subcarriers Allocation .....	128
5.2.4 Bit Loading .....	128
5.3 Modified Shuffled Frog Leaping Algorithm.....	130
5.4 Result's Comparison .....	136
5.5 Analytical and Numerical Benchmark Effectiveness Test.....	139
5.6 Chapter Summary.....	144
<b>CHAPTER SIX CONCLUSION AND FUTURE WORK.....</b>	<b>145</b>
6.1 Conclusion .....	145
6.2 Achieved Objectives .....	146
6.3 Summary of Contributions.....	147
6.4 Limitations of the Research .....	148
6.5 Recommendations for Future Work.....	149

## List of Tables

Table 2.1. Sources of PLC Noise .....	18
Table 2.2. Path variables and Attenuation of N=4 PLC Channels [65] .....	21
Table 2.3 Resource Allocation Techniques in PLC Technology .....	48
Table 2.4 Shuffled Frog-Leaping Algorithm Applications and Comparison .....	55
Table 3.1 Comparison of Communication System Evaluation Approaches.....	75
Table 4.1 Simulation Parameters .....	94
Table 4.2. Optimal Minimum Power Rate Values at Different Users .....	101
Table 4.3. Optimal Maximum Bit Rate Values at Different Users.....	102
Table 4.4. Benchmark Optimization Test Functions .....	112
Table 4.5. Results of Numerical Experiment Optimization.....	113
Table 4.6. Analytical Result of Schwefel Function .....	114
Table 4.7. Optimal Maximum Bit Rate (bits/s/Hz) Values at Different Users .....	117
Table 5.1. Bit Rate (bit/sec) per User.....	127
Table 5.2. Channel Gains (dB) for all Subcarriers of each User.....	128
Table 5.3. Subcarriers Allocation.....	128
Table 5.4. Bit Allocation (Comparison).....	129
Table 5.5 Number of Required Iterations for DeJong's F1 Function .....	141
Table 5.6. Number of Required Iterations for DeJong's F2 Function .....	141
Table 5.7. Number of Required Iterations for Extended Rosenbrock's Function ...	141
Table 5.8. Number of Required Iterations for Rastrigin Function.....	141
Table 5.9 A Comparison of System Capacity using a Power Allocator .....	142
Table 5.10. A Comparison of Transmitted Power of the System for Bit Allocation .....	143

## List of Figures

Figure 1.1. Orthogonal Frequency Division Multiplexing System.....	3
Figure 1. 2. Adaptive Power/bit and Subcarrier Allocation in OFDM System [18]....	5
Figure 1.3. Subcarrier's Power Amount .....	5
Figure 1.4. Research framework .....	12
Figure 2.1. A General PLC Channel (source [58]) .....	17
Figure 2.2. Types of PLC Noise (source [3]).....	18
Figure 2.3. Effect of Noise on the PLC Channel .....	19
Figure 2.4. Periodic Synchronous Impulsive Noise.....	20
Figure 2. 5. PLC Channel Gain, N=4.....	22
Figure 2.6. Basic 2PN Model.....	22
Figure 2.7. OFDM's Spectral Form of Compared to FDM [74].....	24
Figure 2.8. Basic OFDM Transmitter (source [3]) .....	25
Figure 2.9. Mapping/De-mapping Scheme of 16-PSK and 16-AQM (source [3])....	26
Figure 2.10. Shuffled Frog-Leap Algorithm .....	52
Figure 2.11. Modification Sections in SFLA .....	59
Figure 3.1. Research Methodology (source [177]) .....	70
Figure 3.2. Network Performance Evaluation Techniques .....	73
Figure 4.1. OFDM System Block Diagram for Multiusers.....	93
Figure 4.2. Capacity Curves for 14 Users .....	98
Figure 4.3. Power Allocated Rate vs Number of Users .....	99
Figure 4.4. System's Capacity of 16 Users .....	100
Figure 4.5. System Throughput vs Number of Users .....	101
Figure 4.6. Normalized Capacity Ratios for 16 Users .....	103
Figure 4.7 Local Search in the SFLA Scheme.....	105
Figure 4.8. Process of the Proposed Internal Shuffle in SFLA.....	108

Figure 4.9. (a) Memplex Process in SFLA, (b) Memplex Arrangement in the Modified SFLA .....	110
Figure 4.10. Capacity Comparison of SFLA and Modified SFLA_TLBO with 16 Users.....	115
Figure 4.11. Power Allocated Rate vs Number of Users .....	116
Figure 4.12. SFLA vs Modified SFLA_TLBO, 16 Users.....	116
Figure 4.13. Improvement over Fitness Vlaues per Iteration.....	118
Figure 5.1. Process Flow of Subcarrier Allocation Scheme .....	124
Figure 5.2. Subcarrier & Bit Allocation Model Structure.....	126
Figure 5.3. Powers Allocated vs Bit Amounts .....	130
Figure 5.4. Improvement of SFLA based Global and Local Best Frog Using PSO	133
Figure 5.5. Modified Internal Shuffle Process in SFLA .....	134
Figure 5.6 Pseudocode of the Modified SFLA Based TLBO and PSO .....	135
Figure 5.7. Generated Random Power Amount versus Bits .....	137
Figure 5.8. Comparison Result of the Allocated Bits to Power .....	137
Figure 5.9. Amount of Power Allocated to each User .....	138
Figure 5.10. Number of Required Iterations for SFLA and Modified FSLA .....	142

## List of Abbreviations

<b>2NP</b>	Two-port Network
<b>ABC</b>	Artificial Bee Colony
<b>ABC</b>	Artificial Bee Colony
<b>ACO</b>	Ant Colony Optimization
<b>ACO</b>	Ant Colony Optimization
<b>ADSL</b>	Asymmetric Digital Subscriber Line
<b>AWGN</b>	Additive White Gaussian Noise
<b>BER</b>	Bit Error Rate
<b>BPSK</b>	Binary Phase-Shift keying
<b>CDMA</b>	Code Division Multiple Access
<b>CSI</b>	Channel State Information
<b>CTF</b>	Channel Transfer Function
<b>CTF</b>	Channel Transfer Function
<b>dB</b>	Decibel
<b>DMT</b>	Discrete Multi-tone
<b><math>E_b/N_o</math></b>	Energy per Bit to Spectral Noise Density
<b>GA</b>	Genetic Algorithm
<b>ICI</b>	Inter-Carrier Interference
<b>IDFT</b>	Inverse Discrete Fourier Transform
<b>IFFT</b>	Inverse Fast Fourier Transform
<b>ISI</b>	Inter-Symbol Interference
<b>KBACO</b>	Knowledge-based Ant Colony Optimization
<b>LV</b>	Low Voltage
<b>MA</b>	Margin Adaptive
<b>MA</b>	Memetic Algorithm
<b>MAC</b>	Media Access Control
<b>MATSLO</b>	Multi-Agent Tabu Search Local Optimization
<b>MCC-SFLA</b>	Modified Chaos Clonal Shuffled Frog Leaping Algorithm
<b>MHBMO</b>	Modified Honey Bee Mating Optimization
<b>MOGA</b>	Multi-Objective Genetic Algorithm
<b>M-PSK</b>	M-ary Phase Shift Keying
<b>M-PSK</b>	M-ary Phase Shift Keying
<b>M-QAM</b>	M-ary Quadrature Amplitude Modulation
<b>MSFLA</b>	Hybrid Shuffled Frog Leaping Algorithm
<b>MSFLA</b>	Modified Shuffled Frog Leaping Algorithm
<b>MV</b>	Medium Voltage
<b>N/A</b>	Not Applicable
<b>NA</b>	Not Applicable
<b>NBS</b>	Nash Bargaining Solution
<b>NGSA</b>	Non-Denominated Sorting Genetic Algorithm
<b>NP</b>	Non polynomial
<b>OFDM</b>	Orthogonal Frequency-Division Multiplexing
<b>OFDMA</b>	Orthogonal Frequency-Division Multiple Access

<b>PAPR</b>	Peak-to-Average Power Ratio
<b>PDS</b>	Power Density Spectrum
<b>PDS</b>	Power Density Spectrum
<b>PHY</b>	Physical Layer
<b>PLC</b>	Power Line Communication
<b>PSO</b>	Particle Swarm Optimization
<b>PSO</b>	Particle Swarm Optimization
<b>PSO</b>	Particle Swarm Optimization
<b>QoS</b>	Quality of Service
<b>RA</b>	Rate Adaptive
<b>SA</b>	Simulated Annealing
<b>SA</b>	Simulated Annealing
<b>SFLA</b>	Shuffled Frog-Leap Algorithm
<b>TLBO</b>	Teacher Learner Based Optimization
<b>SNR</b>	Signal to Noise Ratio
<b>SPEA</b>	Strength Pareto Evolutionary Algorithm
<b>SVR</b>	Support Vector Regression
<b>TLBO</b>	Teacher Learner Based Optimization
<b><math>Z_L</math></b>	Impedance Load
<b><math>Z_s</math></b>	Impedance Source



# CHAPTER ONE

## INTRODUCTION

### 1.1 Background of the Study

Power Line Communication (PLC) is a high data, video, and voice transmission network over power line grid. It utilises indoor electricity cable for sending high-frequency transmission signals [1]. It meets the Quality of Service (QoS) requirements in high data transmission applications [2]. There are several successful installed projects that made the data transmission over power lines very possible. They are namely PLC, Digital Power Line (DPL), Power Lines Transmission (PLT), and Broadband over Power Lines (BPL).

In PLC, users are able to connect the Internet power line adapters with home electrical appliances on the same grid. Users are then able to control the connected appliances over the same alternating current grid using PLC features. Given such feature, this technology could be applied into controlling building electrical system such as lights and alarms system [3]. In fact, this technology is proven cost-effective by using the existing electrical wiring.

PLC is produced for two purposes, which are recognized and classified as two systems namely, Broadband over PLC and Narrowband over PLC. While Broadband over PLC is used for high data transmission exceeding two Mbps, Narrowband is used for relatively low data transfer, such as those below a few hundred bps which are normally used in electronic systems, air conditioning, heating, and automation meter applications [4, 5].

The contents of  
the thesis is for  
internal user  
only

## References

- [1] M. Li and H.-J. Lin, "Design and implementation of smart home control systems based on wireless sensor networks and power line communications," *IEEE Transactions on Industrial Electronics*, vol. 62, pp. 4430-4442, 2015.
- [2] C. Cano, A. Pittolo, D. Malone, L. Lampe, A. M. Tonello, and A. G. Dabak, "State of the art in power line communications: From the applications to the medium," *IEEE Journal on Selected Areas in Communications*, vol. 34, pp. 1935-1952, 2016.
- [3] H. Hrasnica, A. Haidine, and R. Lehnert, *Broadband powerline communications: network design*: Wiley, 2005.
- [4] T. Sartenaer, "Multiuser communications over frequency selective wired channels and applications to the powerline access network," Ph. D. Dissertation, Univ. Catholique Louvain, Louvain-la-Neuve, Belgium, 2004.
- [5] A. Vukicevic, "Electromagnetic compatibility of power line communication systems," PhD, University of Belgrade, Serbia, 2008.
- [6] L. Tinarwo, "Development of methodologies for deploying and implementing local and medium area broadband PLC networks in offices and residential electric grids," University of Fort Hare, 2008.
- [7] J. Newbury and J. Yazdani, "From narrow to broadband communications using the low voltage power distribution network," in *Proceedings of the 7th International Symposium on Power-Line Communications and its Applications (ISPLC)*, 2003, pp. 26-28.
- [8] J. Härri and J. Kenney, "Multi-channel operations, coexistence and spectrum sharing for vehicular communications," in *Vehicular ad hoc Networks*, ed: Springer, 2015, pp. 193-218.
- [9] A. Letchford, Q. Ni, and Z. Zhong, "An Exact Algorithm for a Resource Allocation Problem in Mobile Wireless Communications," *Department of Management Science, Lancaster University, UK, Tech. Rep*, 2016.
- [10] F. Shams, G. Bacci, and M. Luise, "A survey on resource allocation techniques in OFDM (A) networks," *Computer Networks*, vol. 65, pp. 129-150, 2014.
- [11] L. Lampe, A. M. Tonello, and T. G. Swart, *Power Line Communications: Principles, Standards and Applications from multimedia to smart grid*: John Wiley & Sons, 2016.
- [12] A. Goyal and S. K. Patra, "Performance enhancement of power line communication," in *Information Communication and Embedded Systems (ICICES), 2013 International Conference on*, 2013, pp. 1165-1168.

- [13] M. V. Ribeiro, G. R. Colen, F. V. De Campos, Z. Quan, and H. V. Poor, "Clustered-orthogonal frequency division multiplexing for power line communication: when is it beneficial?," *IET communications*, vol. 8, pp. 2336-2347, 2014.
- [14] A. Chaudhuri and M. R. Bhatnagar, "Optimised resource allocation under impulsive noise in power line communications," *IET communications*, vol. 8, pp. 1104-1108, 2014.
- [15] Z. Ghassemlooy, W. Popoola, and S. Rajbhandari, *Optical wireless communications*: CRC Press Boca Raton, FL, 2012.
- [16] E. Kofidis, D. Katselis, A. Rontogiannis, and S. Theodoridis, "Preamble-based channel estimation in OFDM/OQAM systems: A review," *Signal Processing*, vol. 93, pp. 2038-2054, 2013.
- [17] D. N. C. Tse and S. V. Hanly, "Multiaccess fading channels. I. Polymatroid structure, optimal resource allocation and throughput capacities," *Information Theory, IEEE Transactions on*, vol. 44, pp. 2796-2815, 1998.
- [18] S. Sadr, A. Anpalagan, and K. Raahemifar, "Radio resource allocation algorithms for the downlink of multiuser OFDM communication systems," *IEEE Communications Surveys & Tutorials*, vol. 11, 2009.
- [19] R. Dong, M. Ouzzif, and S. Saoudi, "Utility-based joint resource allocation and scheduling for indoor power line communications," in *Power Line Communications and Its Applications (ISPLC), 2010 IEEE International Symposium on*, 2010, pp. 84-89.
- [20] A. Maiga, J. Baudais, and J. Helard, "An efficient channel condition aware proportional fairness resource allocation for powerline communications," in *Telecommunications, 2009. ICT'09. International Conference on*, 2009, pp. 286-291.
- [21] Z. Xu, M. Zhai, and Y. Zhao, "Optimal resource allocation based on resource factor for power-line communication systems," *Power Delivery, IEEE Transactions on*, vol. 25, pp. 657-666, 2010.
- [22] H. Kim, "Turbo coded orthogonal frequency division multiplexing for digital audio broadcasting," in *Communications, 2000. ICC 2000. 2000 IEEE International Conference on*, 2000, pp. 420-424.
- [23] P. S. Chow, J. M. Cioffi, and J. A. Bingham, "A practical discrete multitone transceiver loading algorithm for data transmission over spectrally shaped channels," *IEEE Transactions on Communications*, vol. 43, pp. 773-775, 1995.
- [24] S. Nader-Esfahani and M. Afrasiabi, "Simple bit loading algorithm for OFDM-based systems," *IET communications*, vol. 1, pp. 312-316, 2007.
- [25] D. Daly, C. Heneghan, and A. Fagan, "Power-and bit-loading algorithms for multitone systems," in *Image and Signal Processing and Analysis, 2003. ISPA 2003. Proceedings of the 3rd International Symposium on*, 2003, pp. 639-644.

- [26] H. Rohling and C. Fellenberg, "Successive bit loading scheme," *Electronics letters*, vol. 45, pp. 214-216, 2009.
- [27] K. Liu, B. Tang, and Y. a. Liu, "Adaptive power loading based on unequal-BER strategy for OFDM systems," *Communications Letters, IEEE*, vol. 13, pp. 474-476, 2009.
- [28] A. Leke and J. M. Cioffi, "A maximum rate loading algorithm for discrete multitone modulation systems," in *Global Telecommunications Conference, 1997. GLOBECOM'97., IEEE*, 1997, pp. 1514-1518.
- [29] A. M. Wyglinski, F. Labeau, and P. Kabal, "Bit loading with BER-constraint for multicarrier systems," *Wireless Communications, IEEE Transactions on*, vol. 4, pp. 1383-1387, 2005.
- [30] L. Goldfeld, V. Lyandres, and D. Wulich, "Minimum BER power loading for OFDM in fading channel," *IEEE Transactions on Communications*, vol. 50, pp. 1729-1733, 2002.
- [31] A. M. Wyglinski, F. Labeau, and P. Kabal, "An efficient bit allocation algorithm for multicarrier modulation," in *Wireless Communications and Networking Conference, 2004. WCNC. 2004 IEEE*, 2004, pp. 1194-1199.
- [32] A. M. Tonello, "Power Line Communications: Advances in Channel Modeling and Filter Bank Modulation," ed: Seminar at Strathclyde University, 2010.
- [33] J. Yoo and S. Choe, "MIMO-OFDM based broadband power line communication with maximum ratio combining," in *Advanced Communication Technology (ICACT), 2012 14th International Conference on*, 2012, pp. 774-777.
- [34] M. Zimmermann and K. Dostert, "An analysis of the broadband noise scenario in powerline networks," in *International Symposium on Powerline Communications and its Applications (ISPLC2000)*, 2000, pp. 5-7.
- [35] M. Zimmermann and K. Dostert, "A multipath model for the powerline channel," *Communications, IEEE Transactions on*, vol. 50, pp. 553-559, 2002.
- [36] B. Hu, Y. Dai, Y. Su, P. Moore, X. Zhang, C. Mao, J. Chen, and L. Xu, "Feature selection for optimized high-dimensional biomedical data using the improved shuffled frog leaping algorithm," *IEEE/ACM Transactions on Computational Biology and Bioinformatics*, 2016.
- [37] V. C. Gungor, D. Sahin, T. Kocak, S. Ergut, C. Buccella, C. Cecati, and G. P. Hancke, "A survey on smart grid potential applications and communication requirements," *IEEE Transactions on Industrial Informatics*, vol. 9, pp. 28-42, 2013.
- [38] L. Jianming, Z. Bingzhen, G. Liang, Y. Zhou, and W. Yirong, "Communication performance of broadband PLC technologies for smart grid," in *Power Line Communications and Its Applications (ISPLC), 2011 IEEE International Symposium on*, 2011, pp. 491-496.

- [39] X. Gao, "Channel Modeling and Resource Allocation in OFDM Systems," Peking University, China, 2001, 2007.
- [40] T. N. Vo, K. Amis, T. Chonavel, and P. Siohan, "Achievable throughput optimization in OFDM systems in the presence of interference and its application to power line networks," *IEEE Transactions on Communications*, vol. 62, pp. 1704-1715, 2014.
- [41] S. B. Lande, J. Helonde, R. Pande, and S. Pathak, "Adaptive subcarrier and bit allocation for downlink ofdma system with proportional fairness," *arXiv preprint arXiv:1111.2160*, 2011.
- [42] H. Moon and D. C. Cox, "Efficient power allocation for coded OFDM systems," *IEEE Transactions on Communications*, vol. 57, pp. 943-947, 2009.
- [43] Z. Xu, M. Zhai, and Y. Zhao, "Optimal resource allocation based on resource factor for power-line communication systems," *IEEE transactions on power delivery*, vol. 25, pp. 657-666, 2010.
- [44] G. R. Colen, L. G. de Oliveira, A. H. Vinck, and M. V. Ribeiro, "A Spectral Compressive Resource Allocation Technique for PLC Systems," *IEEE Transactions on Communications*, vol. 65, pp. 816-826, 2017.
- [45] Y. Wu, Y. Li, and L. Jin, "RESOURCE ALLOCATION ALGORITHM FOR POWER LINE COMMUNICATION SYSTEM WITH IMPERFECT CSI," *RESOURCE*, vol. 12, 2016.
- [46] L. Zhou, C. Zhu, R. Ruby, X. Wang, X. Ji, S. Wang, and J. Wei, "QoS-aware energy-efficient resource allocation in OFDM-based heterogenous cellular networks," *International Journal of Communication Systems*, vol. 30, 2017.
- [47] A. S. Alfa, B. Maharaj, S. Lall, and S. Pal, "Mixed-integer programming based techniques for resource allocation in underlay cognitive radio networks: A survey," *Journal of Communications and Networks*, vol. 18, pp. 744-761, 2016.
- [48] N. Li, W. Sun, Y. Li, M. Peng, and W. Wang, "Joint power allocation and subcarrier pairing for dual-hop OFDM links with full-duplex relaying," in *Wireless Communications & Signal Processing (WCSP), 2016 8th International Conference on*, 2016, pp. 1-6.
- [49] L. Xu, J. Wang, Y.-p. Li, Q. Li, and X. Zhang, "Resource allocation algorithm based on hybrid particle swarm optimization for multiuser cognitive OFDM network," *Expert Systems with Applications*, vol. 42, pp. 7186-7194, 2015.
- [50] K. Illanko, M. Naeem, A. Anpalagan, and D. Androustos, "Energy-Efficient Frequency and Power Allocation for Cognitive Radios in Television Systems," *IEEE systems journal*, vol. 10, pp. 313-324, 2016.
- [51] M. Moretti and A. I. Perez-Neira, "Efficient margin adaptive scheduling for MIMO-OFDMA systems," *IEEE Transactions on Wireless Communications*, vol. 12, pp. 278-287, 2013.

- [52] M. Pischella and J.-C. Belfiore, "Distributed margin adaptive resource allocation in MIMO OFDMA networks," *IEEE Transactions on Communications*, vol. 58, pp. 2371-2380, 2010.
- [53] L. Xu and A. Nallanathan, "Energy-Efficient Chance-Constrained Resource Allocation for Multicast Cognitive OFDM Network," *IEEE Journal on Selected Areas in Communications*, vol. 34, pp. 1298-1306, 2016.
- [54] S. Yin and Z. Qu, "Resource Allocation in Multiuser OFDM Systems With Wireless Information and Power Transfer," *IEEE Communications Letters*, vol. 20, pp. 594-597, 2016.
- [55] M. Isabel, "A Study on The Deregulation of the Electricity Sector and the Implications for the Portuguese Market," Instituto Superior Técnico, 2001.
- [56] C. W. Helstrom, *Elements of signal detection and estimation*: Prentice-Hall, 1994.
- [57] P. Amirshahi-Shirazi, "Broadband Access and Home Networking Through Powerline Networks," PhD, Department of Electrical Engineering, The Pennsylvania State University, Philadelphia: United States, 2006.
- [58] P. Mlynek, M. Koutny, and J. Misurec, "Power line modelling for creating PLC communication system," *International Journal Of Communications*, vol. 1, pp. 13-21, 2010.
- [59] J. Ahola, "Applicability of power-line communications to data transfer of on-line condition monitoring of electrical drives," PhD, Acta Universitatis Lappeenrantaensis, Lappeenranta University of Technology, Lappeenranta: Finland, 2003.
- [60] J. Anatory, N. Theethayi, and R. Thottappillil, "Effects of multipath on OFDM systems for indoor broadband power-line communication networks," *Power Delivery, IEEE Transactions on*, vol. 24, pp. 1190-1197, 2009.
- [61] B. J. Goldhardt, "The viability of power line communications for residential broadband access," Master of Science Internet resource, College of Engineering and Applied Science, University of Colorado, Boulder, 2005.
- [62] M. Babic, M. Hagenau, K. Dostert, and J. Bausch, "Theoretical postulation of PLC channel model," *IST Integrated Project Deliverable D4v2. 0, The OPERA Consortium*, 2005.
- [63] F. Aalamifar, "Viability of powerline communication for smart grid realization," master, Department of Electrical and Computer Engineering, Queen's University Ontario, 2012.
- [64] O. G. Hooijen, "On the relation between network-topology and power line signal attenuation," in *International Symposium on Power Line Communications*, 1998, pp. 45-56.
- [65] V. P. Singh, "Analysis of Power Line Communication Channel Model Using Communication Techniques," North Dakota State University, 2012.

- [66] C. Konate, M. Machmoum, and J. Diouris, "Multi path model for power line communication channel in the frequency range of 1MHz-30MHz," in *EUROCON, 2007. The International Conference on Computer as a Tool*, 2007, pp. 984-989.
- [67] K. M. Dostert, "Power lines as high speed data transmission channels-modelling the physical limits," in *Spread Spectrum Techniques and Applications, 1998. Proceedings., 1998 IEEE 5th International Symposium on*, 1998, pp. 585-589.
- [68] S. Khan, A. F. Salami, W. A. Lawal, A. Z. Alam, and S. A. Hameed, "Characterization of Indoor Power lines As Data Communication Channels Experimental Details and Results," 2008.
- [69] T. Esmailian, F. Kschischang, and P. Gulak, "Characteristics of in-building power lines at high frequencies and their channel capacity," in *ISPLC 2000, Conference Proceedings*, 2000, pp. 52-59.
- [70] M. Bogdanovic, "Power line communication system modeling based on coded OFDM," in *MIPRO, 2012 Proceedings of the 35th International Convention*, 2012, pp. 760-764.
- [71] T. Esmailian, F. Kschischang, and P. Gulak, "An in-building power line channel simulator," in *International Symposium on Power Line Communications and Its Applications (ISPLC)*, 2002, pp. 27-29.
- [72] F. J. Canete, L. Diez, J. A. Cortes, and J. T. Entrambasaguas, "Broadband modelling of indoor power-line channels," *Consumer Electronics, IEEE Transactions on*, vol. 48, pp. 175-183, 2002.
- [73] A. M. Tonello, F. Versolatto, and B. Béjar, "A top-down random generator for the in-home PLC channel," in *Global Telecommunications Conference (GLOBECOM 2011), 2011 IEEE*, 2011, pp. 1-5.
- [74] H. Gilbert, *Understanding broadband over power line*. New York: United State. Auebach Publications: Taylor and Francis Group LCC, 2006.
- [75] R. Prasad, *OFDM for wireless communications systems*: Artech House, 2004.
- [76] J. Bingham and F. Van der Putten, "Network and Customer Installation Interfaces-Asymmetric Digital Subscriber Line (ADSL) Metallic Interface.(T1. 413 Issue 2)," *ANSI T1E1*, pp. 413-1998, 1998.
- [77] T. M. Cover and J. A. Thomas, *Elements of information theory*: John Wiley & Sons, 2012.
- [78] D. Hughes-Hartogs, "Ensemble modem structure for imperfect transmission media," ed: Google Patents, 1989.
- [79] I. Kalet, "The multitone channel," *IEEE Transactions on Communications*, vol. 37, pp. 119-124, 1989.



- [80] L. Cimini, "Analysis and simulation of a digital mobile channel using orthogonal frequency division multiplexing," *IEEE Transactions on Communications*, vol. 33, pp. 665-675, 1985.
- [81] A. Czylik, "Adaptive OFDM for wideband radio channels," in *Global Telecommunications Conference, 1996. GLOBECOM'96. Communications: The Key to Global Prosperity*, 1996, pp. 713-718.
- [82] R. F. Fischer and J. B. Huber, "A new loading algorithm for discrete multitone transmission," in *Global Telecommunications Conference, 1996. GLOBECOM'96. Communications: The Key to Global Prosperity*, 1996, pp. 724-728.
- [83] Z. Liu, Y. Xin, and G. B. Giannakis, "Linear constellation precoding for OFDM with maximum multipath diversity and coding gains," *IEEE Transactions on Communications*, vol. 51, pp. 416-427, 2003.
- [84] D. L. Goeckel and G. Ananthaswamy, "On the design of multidimensional signal sets for OFDM systems," *IEEE Transactions on Communications*, vol. 50, pp. 442-452, 2002.
- [85] Z. Wang and G. B. Giannakis, "Wireless Multicarrier Communications where Fourier Meets Shannon, Department of ECE," *University of Minnesota, Minneapolis MN*, pp. 1-21, 2000.
- [86] N. Prasad, L. Venturino, and X. Wang, "Diversity-multiplexing tradeoff analysis for OFDM systems with subcarrier grouping, linear precoding, and linear detection," *IEEE Transactions on Information Theory*, vol. 56, pp. 6078-6096, 2010.
- [87] R. S. Cheng and S. Verdú, "Gaussian multiaccess channels with ISI: Capacity region and multiuser water-filling," *IEEE Transactions on Information Theory*, vol. 39, pp. 773-785, 1993.
- [88] M. Chiang, "Geometric programming for communication systems," *Foundations and Trends® in Communications and Information Theory*, vol. 2, pp. 1-154, 2005.
- [89] D. P. Bertsekas and A. Scientific, *Convex optimization algorithms*: Athena Scientific Belmont, 2015.
- [90] W. Rhee and J. M. Cioffi, "Increase in capacity of multiuser OFDM system using dynamic subchannel allocation," in *Vehicular Technology Conference Proceedings, 2000. VTC 2000-Spring Tokyo. 2000 IEEE 51st*, 2000, pp. 1085-1089.
- [91] C. Y. Wong, R. S. Cheng, K. B. Lataief, and R. D. Murch, "Multiuser OFDM with adaptive subcarrier, bit, and power allocation," *IEEE Journal on Selected Areas in Communications*, vol. 17, pp. 1747-1758, 1999.
- [92] P. Tsiiaflakis, "Resource Management and Optimization in Multi-User DSL Systems (Middelenbeheer en-optimalisatie van DSL systemen met meerdere gebruikers)," 2009.

- [93] I. Toufik and R. Knopp, "Channel allocation algorithms for multi-carrier systems," in *Vehicular Technology Conference, 2004. VTC2004-Fall. 2004 IEEE 60th*, 2004, pp. 1129-1133.
- [94] F. P. Kelly, A. K. Maulloo, and D. K. Tan, "Rate control for communication networks: shadow prices, proportional fairness and stability," *Journal of the Operational Research society*, vol. 49, pp. 237-252, 1998.
- [95] J.-W. Lee, R. R. Mazumdar, and N. B. Shroff, "Nonconvexity issues for internet rate control with multiclass services: stability and optimality," in *INFOCOM 2004. Twenty-third Annual Joint Conference of the IEEE Computer and Communications Societies*, 2004.
- [96] Z. Cao and E. W. Zegura, "Utility max-min: An application-oriented bandwidth allocation scheme," in *INFOCOM'99. Eighteenth Annual Joint Conference of the IEEE Computer and Communications Societies. Proceedings. IEEE*, 1999, pp. 793-801.
- [97] C. Isheden, Z. Chong, E. Jorswieck, and G. Fettweis, "Framework for link-level energy efficiency optimization with informed transmitter," *IEEE Transactions on Wireless Communications*, vol. 11, pp. 2946-2957, 2012.
- [98] G. Miao, N. Himayat, and G. Y. Li, "Energy-efficient link adaptation in frequency-selective channels," *IEEE Transactions on Communications*, vol. 58, 2010.
- [99] C. Xiong, G. Y. Li, S. Zhang, Y. Chen, and S. Xu, "Energy-efficient resource allocation in OFDMA networks," *IEEE Transactions on Communications*, vol. 60, pp. 3767-3778, 2012.
- [100] E. Baccarelli, M. Biagi, N. Cordeschi, and C. Pelizzoni, "Optimal cross-layer bandwidth adaptation for maximum-throughput VBR media wireless content delivery," in *Communications, 2009. ICC'09. IEEE International Conference on*, 2009, pp. 1-6.
- [101] J.-M. Liang, J.-J. Chen, Y.-C. Wang, and Y.-C. Tseng, "A cross-layer framework for overhead reduction, traffic scheduling, and burst allocation in IEEE 802.16 OFDMA networks," *IEEE Transactions on Vehicular Technology*, vol. 60, pp. 1740-1755, 2011.
- [102] D. S. W. Hui and V. K. N. Lau, "Design and analysis of delay-sensitive decentralized cross-layer OFDMA systems with efficient feedback algorithm," *IEEE Transactions on Wireless Communications*, vol. 8, 2009.
- [103] D. Wang, P. C. Cosman, and L. B. Milstein, "Cross layer resource allocation design for uplink video OFDMA wireless systems," in *Global Telecommunications Conference (GLOBECOM 2011), 2011 IEEE*, 2011, pp. 1-6.
- [104] I. Koutsopoulos and L. Tassiulas, "Cross-layer adaptive techniques for throughput enhancement in wireless OFDM-based networks," *IEEE/ACM Transactions on Networking*, vol. 14, pp. 1056-1066, 2006.

- [105] G. Song and Y. Li, "Cross-layer optimization for OFDM wireless networks-part I: theoretical framework," *IEEE Transactions on Wireless Communications*, vol. 4, pp. 614-624, 2005.
- [106] G. Song and Y. Li, "Cross-layer optimization for OFDM wireless networks-part II: algorithm development," *IEEE Transactions on Wireless Communications*, vol. 4, pp. 625-634, 2005.
- [107] T. Jiang, L. Song, and Y. Zang, *Orthogonal frequency division multiple access fundamentals and applications*: Auerbach Publications, 2010.
- [108] J. Huang, V. G. Subramanian, R. Agrawal, and R. Berry, "Joint scheduling and resource allocation in uplink OFDM systems for broadband wireless access networks," *IEEE Journal on Selected Areas in Communications*, vol. 27, pp. 226-234, 2009.
- [109] J. Huang, V. G. Subramanian, R. Agrawal, and R. A. Berry, "Downlink scheduling and resource allocation for OFDM systems," *IEEE Transactions on Wireless Communications*, vol. 8, pp. 288-296, 2009.
- [110] M. Morelli, M. Moretti, G. Imbarlina, and N. Dimitriou, "Low complexity SNR estimation for transmissions over time-varying flat-fading channels," in *Wireless Communications and Networking Conference, 2009. WCNC 2009. IEEE*, 2009, pp. 1-4.
- [111] M. Moretti, N. Dimitriou, G. Dainelli, V. Corvino, R. Verdone, F. Brah, L. Vanderdorpe, and V. Tralli, "Channel and interference based cross layer OFDMA scheduling," in *Proc. Newcom++/ACORN Workshop, Barcelona, Spain, 2009*, pp. 1-5.
- [112] C.-M. Yen, C.-J. Chang, and L.-C. Wang, "A utility-based TMCR scheduling scheme for downlink multiuser MIMO-OFDMA systems," *IEEE Transactions on Vehicular Technology*, vol. 59, pp. 4105-4115, 2010.
- [113] M. J. Osborne and A. Rubinstein, *A course in game theory*: MIT press, 1994.
- [114] B. Peleg and P. Sudhölter, *Introduction to the theory of cooperative games* vol. 34: Springer Science & Business Media, 2007.
- [115] D. Wu, D. Yu, and Y. Cai, "Subcarrier and power allocation in uplink OFDMA systems based on game theory," in *Neural Networks and Signal Processing, 2008 International Conference on*, 2008, pp. 522-526.
- [116] V. Shah, N. B. Mandayam, and D. J. Goodman, "Power control for wireless data based on utility and pricing," in *Personal, Indoor and Mobile Radio Communications, 1998. The Ninth IEEE International Symposium on*, 1998, pp. 1427-1432.
- [117] D. Yu, D. Wu, Y. Cai, and W. Zhong, "Power allocation based on power efficiency in uplink OFDMA systems: a game theoretic approach," in *Communication Systems, 2008. ICCS 2008. 11th IEEE Singapore International Conference on*, 2008, pp. 92-97.

- [118] H. Kwon and B. G. Lee, "Distributed resource allocation through noncooperative game approach in multi-cell OFDMA systems," in *Communications, 2006. ICC'06. IEEE International Conference on*, 2006, pp. 4345-4350.
- [119] A. Zappone, G. Alfano, S. Buzzi, and M. Meo, "Energy-efficient non-cooperative resource allocation in multi-cell OFDMA systems with multiple base station antennas," in *Online Conference on Green Communications (GreenCom), 2011 IEEE*, 2011, pp. 82-87.
- [120] G. Bacci, A. Bulzomato, and M. Luise, "Uplink power control and subcarrier assignment for an OFDMA multicellular network based on game theory," in *Proceedings of the 5th International ICST Conference on Performance Evaluation Methodologies and Tools*, 2011, pp. 342-351.
- [121] G. Bacci, L. Sanguinetti, M. Luise, and H. V. Poor, "A game-theoretic approach for energy-efficient contention-based synchronization in OFDMA systems," *IEEE Transactions on Signal Processing*, vol. 61, pp. 1258-1271, 2013.
- [122] H. Boche and M. Schubert, "A generalization of Nash bargaining and proportional fairness to log-convex utility sets with power constraints," *IEEE Transactions on Information Theory*, vol. 57, pp. 3390-3404, 2011.
- [123] T. K. Chee, C.-C. Lim, and J. Choi, "A cooperative game theoretic framework for resource allocation in OFDMA systems," in *Communication systems, 2006. ICCS 2006. 10th IEEE Singapore International Conference on*, 2006, pp. 1-5.
- [124] I. Kim, I.-S. Park, and Y. H. Lee, "Use of linear programming for dynamic subcarrier and bit allocation in multiuser OFDM," *IEEE Transactions on Vehicular Technology*, vol. 55, pp. 1195-1207, 2006.
- [125] M. Crussière, J.-Y. Baudais, and J.-F. Hélar, "Adaptive spread-spectrum multicarrier multiple-access over wirelines," *IEEE Journal on Selected Areas in Communications*, vol. 24, pp. 1377-1388, 2006.
- [126] A. Maiga, J.-Y. Baudais, and J.-F. Hélar, "Increase in multicast OFDM data rate in PLC network using adaptive LP-OFDM," in *Adaptive Science & Technology, 2009. ICAST 2009. 2nd International Conference on*, 2009, pp. 384-389.
- [127] Z. Sheng-qing, Z. Li, and Z. Cai-rong, "Design and implementation of OFDM modem for low voltage narrowband powerline communication," in *Computer Science and Information Processing (CSIP), 2012 International Conference on*, 2012, pp. 667-671.
- [128] U. Noreen and S. Baig, "Modified incremental bit allocation algorithm for PowerLine communication in Smart Grids," in *Communications, Signal Processing, and their Applications (ICCSPA), 2013 1st International Conference on*, 2013, pp. 1-6.
- [129] T. Shongwe, V. N. Papilaya, and A. H. Vinck, "Narrow-band Interference Model for OFDM Systems for Powerline Communications," in *Power Line Communications and Its Applications (ISPLC), 2013 17th IEEE International Symposium on*, 2013, pp. 268-272.

- [130] M. Ur Rehman, I. Shoaib, S. Chen, S. Wang, X. Chen, and C. Parini, "Use of Multiband-OFDM UWB for high data rate transmission in powerline communication system," in *Antennas and Propagation (EuCAP), 2013 7th European Conference on*, 2013, pp. 1011-1015.
- [131] S. T. Chung and A. J. Goldsmith, "Degrees of freedom in adaptive modulation: a unified view," *Communications, IEEE Transactions on*, vol. 49, pp. 1561-1571, 2001.
- [132] M. M. Eusuff and K. E. Lansey, "Optimization of water distribution network design using the shuffled frog leaping algorithm," *Journal of Water Resources planning and management*, vol. 129, pp. 210-225, 2003.
- [133] E. Elbeltagi, T. Hegazy, and D. Grierson, "Comparison among five evolutionary-based optimization algorithms," *Advanced engineering informatics*, vol. 19, pp. 43-53, 2005.
- [134] S. Qiu-Hong, "An improved shuffled frog leaping algorithm," *Journal of Chongqing University of Technology (Natural Science)*, vol. 5, p. 019, 2013.
- [135] H. Liu, F. Yi, and H. Yang, "Adaptive grouping cloud model shuffled frog leaping algorithm for solving continuous optimization problems," *Computational intelligence and neuroscience*, vol. 2016, p. 25, 2016.
- [136] T. Niknam and M. Nayeripour, "An efficient multi-objective modified shuffled frog leaping algorithm for distribution feeder reconfiguration problem," *European Transactions on Electrical Power*, vol. 21, pp. 721-739, 2011.
- [137] M. Eusuff, K. Lansey, and F. Pasha, "Shuffled frog-leaping algorithm: a memetic meta-heuristic for discrete optimization," *Engineering optimization*, vol. 38, pp. 129-154, 2006.
- [138] E. Elbeltagi, T. Hegazy, and D. Grierson, "A modified shuffled frog-leaping optimization algorithm: applications to project management," *Structure and Infrastructure Engineering*, vol. 3, pp. 53-60, 2007.
- [139] A. Rahimi-Vahed and A. H. Mirzaei, "A hybrid multi-objective shuffled frog-leaping algorithm for a mixed-model assembly line sequencing problem," *Computers & Industrial Engineering*, vol. 53, pp. 642-666, 2007.
- [140] A. Rahimi-Vahed, M. Dangchi, H. Rafiei, and E. Salimi, "A novel hybrid multi-objective shuffled frog-leaping algorithm for a bi-criteria permutation flow shop scheduling problem," *The International Journal of Advanced Manufacturing Technology*, vol. 41, pp. 1227-1239, 2009.
- [141] H. Shayanfar, R. Jahani, and J. Olamaei, "Comparison of modified shuffled frog leaping algorithm and other heuristic methods for optimal placement of unified power flow controllers in electrical power systems," *Aust J Basic Appl Sci*, vol. 4, pp. 5590-5598, 2010.

- [142] Y. Li, J. Zhou, Y. Zhang, H. Qin, and L. Liu, "Novel multiobjective shuffled frog leaping algorithm with application to reservoir flood control operation," *Journal of Water Resources planning and management*, vol. 136, pp. 217-226, 2010.
- [143] W. Teekeng and A. Thammano, "A combination of shuffled frog leaping and fuzzy logic for flexible job-shop scheduling problems," *Procedia Computer Science*, vol. 6, pp. 69-75, 2011.
- [144] Z. Li and Y. Wang, "An improved shuffled frog leaping algorithm for TSP," *Advances in Multimedia, Software Engineering and Computing Vol. 2*, pp. 139-144, 2012.
- [145] H. Pu, Z. Zhen, and D. Wang, "Modified shuffled frog leaping algorithm for optimization of UAV flight controller," *International Journal of Intelligent Computing and Cybernetics*, vol. 4, pp. 25-39, 2011.
- [146] S. Chittineni, A. Pradeep, G. Dinesh, S. Satapathy, and P. Prasad Reddy, "A parallel hybridization of clonal selection with shuffled frog leaping algorithm for solving global optimization problems (P-AISFLA)," *Swarm, Evolutionary, and Memetic Computing*, pp. 211-222, 2011.
- [147] Y. M. Wang, Y. Bao, J. Chen, and J. Q. Li, "A hybrid shuffled frog leaping algorithm for solving no\_idle permutation flow shop scheduling problems," in *Advanced Engineering Forum*, 2011, pp. 110-115.
- [148] T. Niknam, M. Zare, J. Aghaei, and E. A. Farsani, "A new hybrid evolutionary optimization algorithm for distribution feeder reconfiguration," *Applied Artificial Intelligence*, vol. 25, pp. 951-971, 2011.
- [149] T. Niknam, M. rasoul Narimani, M. Jabbari, and A. R. Malekpour, "A modified shuffle frog leaping algorithm for multi-objective optimal power flow," *Energy*, vol. 36, pp. 6420-6432, 2011.
- [150] A. R. Malekpour, S. Tabatabaei, and T. Niknam, "Probabilistic approach to multi-objective Volt/Var control of distribution system considering hybrid fuel cell and wind energy sources using improved shuffled frog leaping algorithm," *Renewable energy*, vol. 39, pp. 228-240, 2012.
- [151] H. Banati and S. Mehta, "SEVO: bio-inspired analytical tool for uni-modal and multimodal optimization," in *Proceedings of the International Conference on Soft Computing for Problem Solving (SocProS 2011) December 20-22, 2011, 2012*, pp. 557-566.
- [152] M. Tavakolan, B. Ashuri, and N. Chiara, "Applying the shuffled frog-leaping algorithm to improve scheduling of construction projects with activity splitting allowed," in *Management and Innovation for a Sustainable Built Environment MISBE 2011, Amsterdam, The Netherlands, June 20-23, 2011, 2011*.
- [153] C. Yammani, S. Maheswarapu, and S. Matam, "Multiobjective optimization for optimal placement and size of dg using shuffled frog leaping algorithm," *Energy Procedia*, vol. 14, pp. 990-995, 2012.

- [154] X. Li, J. Luo, M.-R. Chen, and N. Wang, "An improved shuffled frog-leaping algorithm with extremal optimisation for continuous optimisation," *Information Sciences*, vol. 192, pp. 143-151, 2012.
- [155] M. Shirvani, P. Shakeri, E. Behzadipour, and I. Baghbani, "PID power system stabilizer design based on shuffled frog leaping algorithm," *Life Sci J*, vol. 9, pp. 1065-1070, 2012.
- [156] A. Kimiyaghalam, A. Ashouri, and M. Beykverdi, "Application of IBSFLA and BSFLA approaches for locating of fault indicators in distribution networks," in *Electrical Power Distribution Networks (EPDC), 2012 Proceedings of 17th Conference on*, 2012, pp. 1-7.
- [157] M. Gomez-Gonzalez, F. Ruiz-Rodriguez, and F. Jurado, "A binary SFLA for probabilistic three-phase load flow in unbalanced distribution systems with technical constraints," *International Journal of Electrical Power & Energy Systems*, vol. 48, pp. 48-57, 2013.
- [158] A. S. Reddy and K. Vaisakh, "Shuffled differential evolution for large scale economic dispatch," *Electric Power Systems Research*, vol. 96, pp. 237-245, 2013.
- [159] E. Fallah-Mehdipour, O. Bozorg Haddad, and M. Marino, "Discussion of "Performance of Shuffled Frog-Leaping Algorithm in Finance-Based Scheduling" by Anas Alghazi, Shokri Z. Selim, and Ashraf Elazouni," *Journal of Computing in Civil Engineering*, vol. 28, pp. 327-328, 2014.
- [160] J. Zhou, E. Dutkiewicz, R. P. Liu, X. Huang, G. Fang, and Y. Liu, "A modified shuffled frog leaping algorithm for PAPR reduction in OFDM systems," *IEEE Transactions on Broadcasting*, vol. 61, pp. 698-709, 2015.
- [161] N. Mahmoudi, H. Orouji, and E. Fallah-Mehdipour, "Integration of Shuffled Frog Leaping Algorithm and Support Vector Regression for Prediction of Water Quality Parameters," *Water Resources Management*, vol. 30, pp. 2195-2211, 2016.
- [162] P. Kaur and S. Mehta, "Resource provisioning and work flow scheduling in clouds using augmented Shuffled Frog Leaping Algorithm," *Journal of Parallel and Distributed Computing*, vol. 101, pp. 41-50, 2017.
- [163] Y. Xu, L. Wang, G. Zhou, and S. Wang, "An effective shuffled frog leaping algorithm for solving hybrid flow-shop scheduling problem," in *International Conference on Intelligent Computing*, 2011, pp. 560-567.
- [164] P. Roy, "A new technique to solve minimum spanning tree (MST) problem using modified shuffled frog-leaping algorithm (MSFLA) with GA cross-over," 2011.
- [165] T. Niknam, B. B. Firouzi, and H. D. Mojarrad, "A new evolutionary algorithm for non-linear economic dispatch," *Expert Systems with Applications*, vol. 38, pp. 13301-13309, 2011.
- [166] T. Niknam, E. A. Farsani, M. Nayeripour, and B. Bahmani Firouzi, "A new tribe modified shuffled frog leaping algorithm for multi-objective distribution feeder

- reconfiguration considering distributed generator units," *European Transactions on Electrical Power*, vol. 22, pp. 308-333, 2012.
- [167] J. Li, Q. Pan, and S. Xie, "An effective shuffled frog-leaping algorithm for multi-objective flexible job shop scheduling problems," *Applied Mathematics and Computation*, vol. 218, pp. 9353-9371, 2012.
- [168] M. Wang and W. Di, "A modified shuffled frog leaping algorithm for the traveling salesman problem," in *Natural Computation (ICNC), 2010 Sixth International Conference on*, 2010, pp. 3701-3705.
- [169] T.-H. Huynh, "A modified shuffled frog leaping algorithm for optimal tuning of multivariable PID controllers," in *Industrial Technology, 2008. ICIT 2008. IEEE International Conference on*, 2008, pp. 1-6.
- [170] A. Jafari, E. Bijami, H. R. Bana, and S. Sadri, "A design automation system for CMOS analog integrated circuits using new hybrid shuffled frog leaping algorithm," *Microelectronics Journal*, vol. 43, pp. 908-915, 2012.
- [171] H. Pakraves and A. Shojaei, "Optimization of industrial CSTR for vinyl acetate polymerization using novel shuffled frog leaping based hybrid algorithms and dynamic modeling," *Computers & Chemical Engineering*, vol. 35, pp. 2351-2365, 2011.
- [172] X. Zhang, Y. Zhang, Y. Shi, L. Zhao, and C. Zou, "Power control algorithm in cognitive radio system based on modified shuffled frog leaping algorithm," *AEU-International Journal of Electronics and Communications*, vol. 66, pp. 448-454, 2012.
- [173] Q.-K. Pan, L. Wang, L. Gao, and J. Li, "An effective shuffled frog-leaping algorithm for lot-streaming flow shop scheduling problem," *The International Journal of Advanced Manufacturing Technology*, vol. 52, pp. 699-713, 2011.
- [174] K. K. Bhattacharjee and S. P. Sarmah, "Shuffled frog leaping algorithm and its application to 0/1 knapsack problem," *Applied Soft Computing*, vol. 19, pp. 252-263, 2014.
- [175] S. Q. Ali and H. M. Hasanien, "Shuffled Frog Leaping Algorithm for Multi-objective Design Optimization of Transverse Flux Linear Motor," *Electric Power Components and Systems*, vol. 44, pp. 1307-1315, 2016.
- [176] S. Ayat and M. R. M. Khoroushani, "The Meta-Heuristic Binary Shuffled Frog Leaping and Genetic Algorithms in Selecting Efficient Significant Features," *J Math Comput Sci*, vol. 13, pp. 130-5, 2014.
- [177] Norshuhada Shiratuddin and S. Hassan, *Design Research in Software Development Construction and Linking Research Questions, Objectives, Methods and Outcomes*. Sintok, Kedah: Penerbit University Malaysia Utara, 2010.
- [178] S. Hassan, "Simulation-based Performance Evaluation of TCP-friendly Protocols for Supporting Multimedia Applications in the Internet," University of Leeds (School of Computing), 2002.



- [179] G. Osman, "Scaleable and Smooth TCP-Friendly Receiver-Based Layered Multicast Protocol," PhD, School of Computing, Universiti Utara Malaysia, Sintok, 2008.
- [180] O. M. D. Al-Momani, "Dynamic redundancy forward error correction mechanism for the enhancement of Internet-based video streaming," PhD, School of Computing, Universiti Utara Malaysia, Sintok: Malaysia, 2010.
- [181] M. M. Kadhum, "Fast congestion notification mechanism for next generation routers," PhD, School of Computing, Ph. D. thesis, Universiti Utara Malaysia, Sintok, 2010.
- [182] O. M. A. Al-Hazaimah, "New cryptographic algorithms for enhancing security of voice data," PhD, School of Computing, Universiti Utara Malaysia, UUM, Sintok: Malaysia, 2010.
- [183] D. Houcque, "Introduction to MATLAB for Engineering Students," *Northwestern University*, 2005.
- [184] F. Versolatto and A. M. Tonello, "An MTL theory approach for the simulation of MIMO power-line communication channels," *Power Delivery, IEEE Transactions on*, vol. 26, pp. 1710-1717, 2011.
- [185] M. Korki, N. Hosseinzadeh, H. L. Vu, T. Moazzeni, and C. H. Foh, "A channel model for power line communication in the smart grid," in *Power Systems Conference and Exposition (PSCE), 2011 IEEE/PES*, 2011, pp. 1-7.
- [186] H. Zattar, L. Salek, and G. Carrijo, "An evaluation of power line communication channel modelling for indoor environment application," in *Telecommunications (CONATEL), 2011 2nd National Conference on*, 2011, pp. 1-6.
- [187] A. M. Tonello, F. Versolatto, B. Béjar, and S. Zazo, "A fitting algorithm for random modeling the PLC channel," *Power Delivery, IEEE Transactions on*, vol. 27, pp. 1477-1484, 2012.
- [188] S. Rahman and S. Majumder, "Performance analysis of a power line communication system with multi-carrier DS-CDMA," in *Electrical Engineering and Information & Communication Technology (ICEEICT), 2014 International Conference on*, 2014, pp. 1-6.
- [189] V. Degardin, I. Junqua, M. Lienard, P. Degauque, and S. Bertuol, "Theoretical approach to the feasibility of power-line communication in aircrafts," *Vehicular Technology, IEEE Transactions on*, vol. 62, pp. 1362-1366, 2013.
- [190] R. Negi and K. Sharma, "Image Transmission in OSTBC MIMO-PLC Over Nakagami-m Distributed Background Noise," in *Proceedings of the International Congress on Information and Communication Technology*, 2016, pp. 513-523.
- [191] A. V. Nikitin, D. Scutti, B. Natarajan, and R. L. Davidchack, "Blind adaptive analog nonlinear filters for noise mitigation in powerline communication systems," in *Power Line Communications and its Applications (ISPLC), 2015 International Symposium on*, 2015, pp. 1-6.

- [192] M. Zimmermann and K. Dostert, "Analysis and modeling of impulsive noise in broad-band powerline communications," *IEEE transactions on Electromagnetic compatibility*, vol. 44, pp. 249-258, 2002.
- [193] Y. Ma, P. So, and E. Gunawan, "Performance analysis of OFDM systems for broadband power line communications under impulsive noise and multipath effects," *IEEE transactions on power delivery*, vol. 20, pp. 674-682, 2005.
- [194] H. Meng, S. Chen, Y. Guan, C. Law, P. So, E. Gunawan, and T. Lie, "A transmission line model for high-frequency power line communication channel," in *Power System Technology, 2002. Proceedings. PowerCon 2002. International Conference on*, 2002, pp. 1290-1295.
- [195] V. P. Singh, "Analysis of Power Line Communication Channel Model Using Communication Techniques," 701 Master, Circulation, North Dakota State University, Dakota, 2012.
- [196] R. Pighi, M. Franceschini, G. Ferrari, and R. Raheli, "Fundamental performance limits of communications systems impaired by impulse noise," *IEEE Transactions on Communications*, vol. 57, pp. 171-182, 2009.
- [197] I. C. Wong and B. Evans, *Resource allocation in multiuser multicarrier wireless systems*: Springer Science & Business Media, 2007.
- [198] N. A. Odhah, M. I. Dessouky, W. E. Al-Hanafy, and F. Abd El-Samie, "Low complexity greedy power allocation algorithm for proportional resource allocation in multi-user OFDM systems," *Journal of Telecommunications and Information Technology*, pp. 38-45, 2012.
- [199] T. Ibaraki and N. Katoh, *Resource allocation problems: algorithmic approaches*: MIT press, 1988.
- [200] H. Yin and H. Liu, "An efficient multiuser loading algorithm for OFDM-based broadband wireless systems," in *Global Telecommunications Conference, 2000. GLOBECOM'00. IEEE*, 2000, pp. 103-107.
- [201] A. Akbari, R. Hoshyar, and R. Tafazolli, "Energy-efficient resource allocation in wireless OFDMA systems," in *Personal Indoor and Mobile Radio Communications (PIMRC), 2010 IEEE 21st International Symposium on*, 2010, pp. 1731-1735.
- [202] K. Xiong, P. Fan, K. B. Letaief, S. Yi, and M. Lei, "Resource allocation for minimal downlink delay in two-way OFDM relaying with network coding," in *Communications (ICC), 2012 IEEE International Conference on*, 2012, pp. 5343-5347.
- [203] M. N. Yadav, A. N. Yadav, and R. J. Yadav, "Performance Analysis of Linear and Nonlinear Resource Allocation Techniques in OFDM System," *International Journal of Conceptions on Electronics and Communication Engineering*, vol. 3, April 2015.

- [204] Z. Shen, J. G. Andrews, and B. L. Evans, "Optimal power allocation in multiuser OFDM systems," in *Global Telecommunications Conference, 2003. GLOBECOM'03. IEEE*, 2003, pp. 337-341.
- [205] S. G. ROOPASHREE, "A Low Complexity Scheduling for Downlink of Ofdm System with Proportional Resource Allocation," presented at the ASAR International Conference, Bangalore, 2013.
- [206] M. G. Kibria and L. Shan, "Resource allocation optimization for users with different levels of service in multicarrier systems," *IEEE Signal Processing Letters*, vol. 22, pp. 1869-1873, 2015.
- [207] G. Kulkarni, S. Adlakha, and M. Srivastava, "Subcarrier allocation and bit loading algorithms for OFDMA-based wireless networks," *IEEE transactions on mobile computing*, vol. 4, pp. 652-662, 2005.
- [208] C. Nam, C. Joo, and S. Bahk, "Joint subcarrier assignment and power allocation in full-duplex OFDMA networks," *IEEE Transactions on Wireless Communications*, vol. 14, pp. 3108-3119, 2015.
- [209] C. He, G. Y. Li, F.-C. Zheng, and X. You, "Energy-efficient resource allocation in OFDM systems with distributed antennas," *IEEE Transactions on Vehicular Technology*, vol. 63, pp. 1223-1231, 2014.
- [210] Q. Qi, A. Minturn, and Y. Yang, "An efficient water-filling algorithm for power allocation in OFDM-based cognitive radio systems," in *Systems and Informatics (ICSAI), 2012 International Conference on*, 2012, pp. 2069-2073.
- [211] A. Sultana, L. Zhao, and X. Fernando, "Power Allocation Using Geometric Water Filling for OFDM-Based Cognitive Radio Networks," in *Vehicular Technology Conference (VTC-Fall), 2016 IEEE 84th*, 2016, pp. 1-5.
- [212] K. Gunaseelan, R. Venkateswari, and A. Kandaswamy, "A novel efficient resource allocation algorithm for multiuser OFDM systems," *IETE Technical Review*, vol. 25, pp. 201-208, 2015.
- [213] H.-L. Liu and Q. Wang, "A resource allocation evolutionary algorithm for OFDM based on Karush-Kuhn-Tucker conditions," *Mathematical Problems in Engineering*, vol. 2013, 2013.
- [214] Q. Wang, H.-L. Liu, J.-c. Li, and Y. Li, "A resource allocation evolutionary algorithm for OFDM system," *International Journal of Computational Science and Engineering*, vol. 14, pp. 55-63, 2017.
- [215] S. Sadeque, I. Ahmed, and R. Vaughan, "Impact of individual and joint optimizations in multi-user OFDM resource allocation by modified PSO," in *Electrical and Computer Engineering (CCECE), 2011 24th Canadian Conference on*, 2011, pp. 001233-001237.
- [216] T.-D. Nguyen and Y. Han, "A proportional fairness algorithm with QoS provision in downlink OFDMA systems," *IEEE Communications Letters*, vol. 10, 2006.

- [217] R. V. Rao, "Teaching-Learning-Based Optimization Algorithm," in *Teaching Learning Based Optimization Algorithm*, ed: Springer, 2016, pp. 9-39.
- [218] D. Mora-Melia, P. L. Iglesias-Rey, F. J. Martínez-Solano, and P. Muñoz-Velasco, "The Efficiency of Setting Parameters in a Modified Shuffled Frog Leaping Algorithm Applied to Optimizing Water Distribution Networks," *Water*, vol. 8, p. 182, 2016.
- [219] H. Huang, H. Qin, Z. Hao, and A. Lim, "Example-based learning particle swarm optimization for continuous optimization," *Information Sciences*, vol. 182, pp. 125-138, 2012.
- [220] X. Yao, Y. Liu, and G. Lin, "Evolutionary programming made faster," *IEEE Transactions on Evolutionary computation*, vol. 3, pp. 82-102, 1999.
- [221] T. Vo, K. Amis, T. Chonavel, and P. Siohan, "Achievable Throughput Optimization in OFDM Systems in the Presence of Interference and its Application to Power Line Networks," *IEEE Transactions on Communications*, vol. 62, pp. 1704-1715, 2014.
- [222] T. N. Vo, K. Amis, T. Chonavel, and P. Siohan, "A computationally efficient discrete bit-loading algorithm for OFDM systems subject to spectral-compatibility limits," *IEEE Transactions on Communications*, vol. 63, pp. 2261-2272, 2015.
- [223] T. N. Vo, K. Amis, T. Chonavel, and P. Siohan, "A Low-Complexity Bit-Loading Algorithm for OFDM Systems Under Spectral Mask Constraint," *IEEE Communications Letters*, vol. 20, pp. 1076-1079, 2016.
- [224] D. Wang, Y. Cao, L. Zheng, and Z. Du, "Iterative group-by-group bit-loading algorithms for OFDM systems," *IEEE Transactions on Vehicular Technology*, vol. 62, pp. 4131-4135, 2013.
- [225] X. Guo, S. Zhang, L. Guo, and Y. Chen, "An Improved Dynamic Resource Allocation in Multi-users OFDM System," in *Wireless Communications, Networking and Applications*, ed: Springer, 2016, pp. 741-748.
- [226] I. C. Wong, Z. Shen, B. L. Evans, and J. G. Andrews, "A low complexity algorithm for proportional resource allocation in OFDMA systems," in *Signal Processing Systems, 2004. SIPS 2004. IEEE Workshop on*, 2004, pp. 1-6.
- [227] H. Wanming and Y. Shouyi, "Energy-Efficient Power Allocation in OFDM-based Relaying Networks," *International Journal of Multimedia and Ubiquitous Engineering*, vol. 10, pp. 209-220, 2015.
- [228] H. N. Vu and H.-Y. Kong, "Joint subcarrier matching and power allocation in OFDM two-way relay systems," *Journal of Communications and Networks*, vol. 14, pp. 257-266, 2012.
- [229] F. Marini and B. Walczak, "Particle swarm optimization (PSO). A tutorial," *Chemometrics and Intelligent Laboratory Systems*, vol. 149, pp. 153-165, 2015.

- [230] M. A. Potter and K. A. De Jong, "A cooperative coevolutionary approach to function optimization," in *International Conference on Parallel Problem Solving from Nature*, 1994, pp. 249-257.
- [231] J. D. V. Henaó, "An introduction to chaos-based algorithms for numerical optimization," *Avances en Sistemas e Informática*, vol. 8, pp. 51-60, 2011.