Ain Shams University
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Performance Evaluation of Single Carrier Frequency Division Multiple Access Systems

A Thesis
Submitted in partial fulfillment for the requirements for the degree of Doctor of Philosophy in Communications Engineering
(Electronics and Communications Engineering)

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"Performance Evaluation of Single Carrier Frequency Division Multiple Access Systems"

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Statement

This dissertation is submitted as a partial fulfillment of the degree of Doctor of Philosophy in Electrical Engineering (Electronics and Communications Engineering), Faculty of Engineering, Ain Shams University.

The author carried out the work included in this thesis and no part of it has been submitted for a degree or a qualification at any other scientific entity.

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قَالَ تَعَالَىٰ:

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List of Publications

1. **Mohamed Mostafa**, Fatma Newagy, Ismail Hafez, "Joint complex regularised zero-forcing equalisation and CFO compensation for MIMO SC-FDMA systems" IET Communications, vol.10, issue.16, pp.2245–2251, Nov. 2016.

2. **Mohamed Mostafa**, Fatma Newagy, Ismail Hafez, "performance investigation of multi-user SC-FDMA MIMO systems", accepted for publication in the IEEE 28th The International Conference on Microelectronics (IEEE ICM'16). ICM 2016 which held in Cairo, Egypt, on December 17-20, 2016.

3. **Mohamed Mostafa**, Fatma Newagy, Ismail Hafez, "Complex Regularized Zero Forcing Precoding for Massive MIMO Systems" in IET Communications (under review)

Abstract

The continuous need for a high-speed wireless access technology has received more attention, especially in the past decade with the development of the 4G communication technologies. Single carrier – frequency division multiple access scheme is one of the promising technologies, which have proved its robustness against various impairments in severe wireless channel conditions.

In this thesis, the research work is dedicated to analyze and investigate the performance improvement of these systems via frequency domain equalization and precoding schemes. A novel frequency domain equalizer as well as a proposed precoder is introduced. The bit error rate, as function of the signal to noise ratio, is the performance metric of interest which is utilized to evaluate the proposed schemes under different standard hypothetical and realistic channel conditions. Moreover, the quadrature phase shift keying (QPSK).

On the other hand, the energy efficiency, in bits per unit energy, is adopted as a system level performance evaluation metric. Furthermore, the analysis and performance evaluation has been extended to include the effects of the multi-user interference for all propagation environments. The carrier frequency offset is also included throughout the analysis and simulations. Since the use of massive, multiple input multiple output (MIMO) systems an unavoidable part of next generation communication networks, the performance of the considered system is studied when the number of antennas is increased such that the system tends to the massive MIMO regime.

ABSTRACT

The simulation results indicate that the performance of the a SC-FDMA system using the proposed schemes is highly competitive to the conventional zero forcing (ZF) and minimum mean squared error (MMSE) schemes assuming different CFOs, modulation schemes and channel models. Finally, some design guidelines are concluded to compromise between the BER and the EE during the system level and link level design phases.

Key Words:

- Orthogonal Frequency division multiple access
- frequency domain equalizer
- Single Carrier
- Multi carrier
- Energy Efficiency
- Precoders

Table of Contents

Acknowledgements ……..…….…..… vi

List of Publications ……..… vii

Abstract ……..... ix

Table of Contents ……..……..……..…… x

List of Abbreviations ……...…….…… xvii

List of Figures ……..…..…..... xxi

List of Tables ……...…….…..… xxiv

List of Symbols ……...……...…... xxv

Chapter 1 Introduction 1

1.1 Thesis Objectives ……..…… 1

1.2 Motivation ……..…… 2

1.3 thesis Contribution ……..... 3

1.4 Dissertation outline ……..... 4

Chapter 2 Single and Multi-Carrier Communication Systems 6

2.1 Historical development of cellular Wireless Communications …..... 6

2.2 Vehicular RF Channel ……...… 8

2.2.1 Fast and Slow Fading ……...……. 9

2.2.2 Frequency Selective and Frequency Fading Flat …..…..… 9

2.2.3 Channel Equalization ……..... 10

2.3 Multi-Carrier Communication Systems ……..... 12

2.3.1 OFDM System ……...…..…… 13

2.3.2 OFDMA System …….. 16

2.3.3 MC-CDMA System …….…… 17

2.4 Single-Carrier Communication Systems ……..... 18

2.4.1 SC-FDM System …..... 19

2.4.2 SC-FDMA System …….…. 21

2.5 Conclusion ……. 22

Chapter 3 SC-FDMA System 23

3.1 Introduction ……...…..… 23

3.2 Subcarriers Mapping Techniques ……..… 24

3.3 SC-FDMA System Model ……..... 26

3.4 the presentation of SC-FDMA symbols in time domain ……...… 32

3.4.1 Time Domain Symbols of the IFDMA System…….. 32

3.4.2 Time Domain Signals for LFDMA techniques ……..… 33

3.5 Comparison between the OFDMA System and the SC-FDMA System ……... 35

3.6 The Peak-to-Average Power Ratio problem ……..…... 36

3.6.1 The Power Amplifier ……..……..…… 36

3.6.2 The impact of A/D and D/A Resolution ……..… 40

3.6.3Windowing Filters ……...……..…….. 40

3.7 Impact of the CFO induced ICI on the BER ……...…..…. 42

3.8 Conclusion ……..…… 43

Chapter 4 Massive MIMO SC-FDMA Systems 44

4.1 Introduction ……...……..……. 44

4.2 System model Overview ……..... …… 45

4.3 SC-FDMA UE-BS Transceiver Chain ……..……. 47

4.3.1 The transmitter side……..... 48

4.3.1.1Precoder ……..……..… 48

4.3.2 Multiple Port MIMO Channel Model ……... 50

4.3.3 Receiver Processing …….……..... 52

4.3.3.1 Single Carrier Frequency Domain Equalization (SC-FDE) and Symbol Detection ……..… 55

4.4 Performance Evaluation Metrics ……..... 55

4.4.1 Complexity ……..……..... 56

4.4.1.1 Overall system Complexity ……...… 57

4.4.1.2 Complexity of TX/RX chains ……...…….. 57

4.4.2 Energy Efficiency ……...….……...… 57

4.4.3 Bit Error Rate ……..…….. 58

4.5 Conclusion …….…… 58

Chapter 5 Equalization Schemes for Massive MIMO SC-FDMA Systems: Link Level Analysis 59

5.1 Introduction ……...……..…….. 59

5.2 Link Level System Model ……...……...……...… 61

5.2.1Noise and ICI Analysis ……..……..... 62

5.3 The proposed JCRZF equalizer ……..……... 65

5.3.1 Transformation of the MIMO channel into two equivalent SISO Channels ……..……..…… 66

5.3.2 Equalization and ICI Mitigation ……....….. 67

5.4 Complexity analysis ……..…….... 70

5.5 Simulation results and analysis ……..……... 71

5.5.1 Simulation Setup …… 71
5.5.2 Results and discussion ……..…….……..… 72

5.6 Conclusion ……..……... 88

Chapter 6 Precoding Schemes for Massive MIMO SC-FDMA Systems: System Level Analysis 89

6.1 Introduction ……...…….....…….. 89

6.2 Energy efficiency (general) ……...……...…..... 91

6.3 Data Rate and SNR Analysis ……...…….. 94

6.4 Transceiver Power Consumption Analysis ……..……. 95

6.4.1 The average Transmitted Power …….……..... 95

6.4.2 Core power consumption …….……..……. 96

6.4.3 Circuit Power Consumption Model ……..…… 97

6.4.3.1 Transceiver Chains …… 98

6.4.3.2 Channel Estimation ……..……...…… 98

6.4.3.3 Coding and Decoding ……...…...… 99

6.4.3.4 Backhaul ……...……...… 99

6.4.3.5 Linear Processing ……..... 100

6.5 Precoding schemes for massive MIMO ……...…….....… 100

6.5.1 Energy Efficiency Analysis for ZF Precoding ….....… 102

6.5.2 Energy Efficiency Analysis for MMSE precoding ……..… 103

6.5.3Energy Efficiency Analysis for Complex Regularized Zero Forcing Precoding ……...…..... 104

6.6 Simulation Results and Analysis ……..……..……. 109

6.6.1 Simulation Setup and Methodology ……... 109

6.6.2 Results and discussion ……..... 111

6.7 Conclusion ……...……...…..……. 117

Chapter 7 Conclusions and Future Work 118

7.1 Conclusions ……..……...……..….. 118

7.2 Future Work ……...…...……...… 120

References ……..……..……... 122

Appendix A Channel model ……...…..…… 132