

當高斯相關特性出現於接收分支中 MC-CDMA 系統的效能分析研究

劉昱吟、陳雍宗

E-mail: 9511022@mail.dyu.edu.tw

摘要

本論文旨在研究MC-CDMA (multi-carrier coded-division multiple-access) 系統工作於不相關 (uncorrelated) 與相關 (correlated) 衰落通道的Nakagami-m統計分佈。其中相關分支假設呈現高斯相關 (correlated Gaussian) 模型，在MC-CDMA系統中，其接收方法採用二位元相移鍵 (binary phase shift keying, BPSK)、非同調頻移鍵 (noncoherent frequency shift keying, NCFSK) 以及差分同調相移鍵 (differential coherent phase shift keying, DCPSK) 等調變架構，並分析位元錯誤率(bit error rate, BER)效能。為了得到分支之間任意相關通道的完全式，本文採用Gamma變數的機率密度函數(probability density function, pdf)，以避免在最大比例合成(maximal ratio combining, MRC)輸出，求得SNR(signal-to-noise ratio)之機率密度函數的困難。由本文所分析之系統BER效能得知，MC-CDMA系統極易受衰落通道相關性影響的，就MC-CDMA系統的BER效能而言，考慮無相關分支與相關分支的現象時，兩者之間約有3dB以上之差異。

關鍵詞：MC-CDMA系統，不相關通道，相關通道，Nakagami-m衰落計，最大比例合成(MRC)分集

目錄

封面內頁 簽名頁 授權書	iii	中文摘要	
.	iv	英文摘要	
v 誌謝	vi	目錄	
.	vii	圖目錄	x
目錄	xii	第一章 緒論	
.	1	第二章 多載波-CDMA系統概述	6
.	6	2.1 前言	6
.	6	2.2 MC-CDMA系統簡介	6
型	8	2.2.1 發射機架構	8
.	8	2.2.1.2 接收機架構	8
.	10	2.3 MC-DS-CDMA系統簡介	12
.	14	2.3.1 系統模型	12
.	14	2.3.1.1 發射機架構	14
.	14	2.3.1.2 接收機架構	16
2.3.1.3 效能分析	20	第三章 一般衰落通道理論	26
3.1 訊號衰落介紹	26	3.2 多重路徑及多重衰落簡介	26
.	27	3.3 多重路徑衰落所造成的效應	28
.	29	3.4 衰落形式的分類	29
上的變動性	30	3.4.1 小尺度衰落	29
.	30	3.4.1.1 時域上的擴散性	29
.	30	3.4.1.2 時域上的擴散性	29
.	32	3.4.2 大尺度衰落	32
.	32	3.4.2.1 路徑損耗	32
.	32	3.4.2.2 遮蔽效應	35
3.6常用通信波道統計分佈介紹與比較	39	3.5衰落通道的數學模型	37
.	39	3.6.1 Normal(Gaussian)衰落分佈	40
Rayleigh衰落分佈	42	3.6.2	40
Nakagami-m衰落分佈	49	3.6.3 Rice衰落分佈	45
.	49	3.6.4	45
53 4.1 通道模型	53	第四章 系統效能分析	
53 4.1.1 前言	53	4.1 通道模型	53
53 4.1.2 不相關Nakagami-m通道	54	4.1.1 前言	53
.	54	4.1.2 不相關Nakagami-m通道	54
變系統	56	4.2 同調調變系統	59
.	56	4.3 非同調調變系統	59
不相關通道	59	4.3.1	59
.	59	4.3.2 相關通道	61
分析結果	62	4.4 數值分析結果	61
.	62	第五章 結論	
.	68	參考文獻	69

參考文獻

[1] L. B. Milstein, "A Conceptual Overview of Wideband Code Division Multiple Access", IEEE Sixth International Symposium on Spread Spectrum Techniques and Applications, Vol. 1, pp. 226-229, 2000.

[2] R. Esmailzadeh and M. Nakagawa, "TDD-CDMA for the 4th Generation of Wireless Communications", IEEE Wireless Commun., Vol. 10, No. 4, pp. 8-15, 2003.

- [3] S. Kondo and L. B. Milstein, "Multicarrier CDMA System with Cochannel Interference Cancellation", Proc. Vehicular Technology Conferenc ' 94, pp. 640-1644, 1994.
- [4] N. Yee, J. -P. Linnartz, and G. Fettweis, "Multi-carrier CDMA in Indoor Wireless Radio Networks", IEICE Trans. on Commun., Vol. E77-B, No.7, pp. 900-904, 1994.
- [5] S. Kondo, L. B. Milstein, "On the Performance of Multicarrier DS-CDMA Systems", IEEE Trans. on Commun., pp. 3101, 1995.
- [6] S. Hara and P. Ramjee, "Design and Performance of Multicarrier CDMA System in Frequency-Selective Rayleigh Fading Channels", IEEE Trans. on Vehicular Technology Vol. 48, No. 5, pp. 1584-1595, 1999.
- [7] D. N. Rowitch and L. B. Milstein, "Coded Multicarrier DS-CDMA in the Presence of Partial Band Interference", Proc. MILCOM ' 96, Vol. 1, pp. 204-209, 1996.
- [8] W. Xu and L. B. Miltstein, "On the Performance of Multicarrier RAKE Systems", Proc. GLOBECOM ' 97, Vol. 1, pp. 295-299, 1997.
- [9] M. K. Simon, M. – S. Alouini, "BER Performance of Multicarrier DS-CDMA System over Generalized Fading Channels", Communication Theory Mini-Conference, pp. 72-77, 1999.
- [10] R. E. Ziemer, "Effect of Correlation Between Subcarrier of an MCM/DSSS Communication System", Vehicular Technology Conference, 'Mobile Technology for the Human Race', IEEE 46th, Vol. 1, pp. 146-150, 1996.
- [11] Zexian Li, M. Latva-aho, "Error Probability for MC-CDMA in Nakagami-m Fading Channels Using Equal Gain Combining", IEEE International Conference on Commun, Vol. 1, pp. 227-231, 2002.
- [12] Q. Shi, M. Latva-aho, "Performance Analysis of MC-CDMA in Rayleigh Fading Channels with Correlated Envelopes and Phases", IEE Proc -Commun, Vol. 150, No. 3, pp. 214-220, 2003.
- [13] Taeyoung Kim, et. al, "Performance of an MC-CDMA System with Frequency Offsets in Correlated Fading", IEEE International Conference on Commun, Vol. 2, pp. 1095-1099, 2000.
- [14] Junhyun Park, et. al., "Performance of MC-CDMA Systems in Non-independent Rayleigh Fading", IEEE International Conference on Commun, Vol. 1, pp. 506-510, 1999.
- [15] W. Xu, L. B. Milstein, "Performance of Multicarrier DS-CDMA Systems in the Presence of Correlation Fading", Vehicular Technology Conference, IEEE 47th, Vol. 3, pp. 2050-2054, 1997.
- [16] Qinghua shi, M. Latva-aho, "Exact Error Floor for Downlink MC-CDMA with Maximal Ratio Combining in Correlated Nakagami Fading Channels", International Zurich Seminar on Broadband Communications. Access-transmission, Networking, Eth Zurich SW, pp. 37-1-37-5, 2002.
- [17] Chan Kyu Kim, and Yong Sos Cho, "Performance of a Wireless MC-CDMA System with an Antenna Array in a Fading Channel: Reverse Link", IEEE Trans. on Commun, Vol. 48, No. 8, pp. 1257-1261, 2000.
- [18] S. Abeta, H. Atarashi, and M. Sawahashi, "Forward Link Capacity of Coherent DS-CDMA and MC-CDMA Broadband Packet Wireless Access in a Multi-cell Environment", IEEE Vehicular Technology Conference, Vol. 5, pp. 2213-2218, 2000.
- [19] Hongnian Xing, and Markku Renfors, "The Performance Evaluation of the Multi-Carrier CDMA System with Frequency Domain Equalization", IEEE Vehicular Technology Conferenc, Vol. 4, pp. 2362-2366, 1999.
- [20] S. Sigdel et. al., "Performance Evaluation of Multicarrier CDMA Uplink System with Antenna Array and Multiuser Detection over Correlated Multipath Channel", IEEE Vehicular Technology Conference, Vol. 4, pp. 1958-1962, 2002.
- [21] David J. Sadler, and A. Manikas, "Reduction of Intracell and Intercell Interference for Array MC-DS-CDMA", IEEE Global Telecommunications Conference, Vol. 4, pp. 2167-2171, 2003.
- [22] Merouane Debbah, "Capacity of a Downlink MC-CDMA Multi-cell Network", IEEE International Conference on Acoustics, Speech, and Signal Processing, Vol. 4, pp. IV-761-I-764, 2004.
- [23] E. A. Sourour and M. Nakagawa, "Performance of Orthogonal Multicarrier CDMA in a Multipath Fading Channel", IEEE Trans. on Commun., Vol. 44, pp. 356-367, 1996.
- [24] Matthias Patzold, "Mobile Fading Channel", Wiley, pp. 3-7, 2002.
- [25] S. Bernard, "Digital Communications Fundamentals and Applications", Prentice Hall International, Inc, pp. 962-966, 2001.
- [26] T. S. Rappaport, "Wireless Communications Principles and Practice. Prentice Hall PTR, New Jersey, 1996.
- [27] B. Sklar, "Rayleigh Fading Channels in Mobile Digital Communication Systems Part 1: Characterization", IEEE Commun. Magazine, pp. 90-100, 1997.
- [28] B. Sklar, "Digital Communications:Fundamental and Applications", Prentice-Hall PTR, New Jersey, 1988.
- [29] K. Feher, "Wireless Digital Communications:Modulation and Spread Spectrum Applications", Prentice Hall PTR, New Jersey, 1995.
- [30] J. G. Proakis, "Digital Communications", 3rd ed., McGraw-Hill, New York, 1995.
- [31] Yacoub, M. D., "Foundations of Mobile Radio Engineering", CRC Press Inc, 1993.
- [32] Mondre, E., "Complex and Envelope Covariance for Rician Fading Communication Channels Communications", IEEE Trans. [legacy, pre - 1988], Vol. 19, Issue: 1, pp. 80-84, 1971.
- [33] D. Middle, "An Introduction to Statistical Communication Systems and Techniques", New York:McGraw-Hill, 1966.

- [34] Suzuki, H., " A Statistical Model for Urban Radio Propagation " , IEEE Trans. on Commun., Vol. 27, No. 4, pp. 657-670, 1979.
- [35] Nakagami, M., " The m-Distribution-A General Formula of Intensity Distribution of Rapid Fading " , Statistic Methods of in Radio Wave Propagation, Pergamon Press, New York, pp. 3-36, 1960.
- [36] I. S. Gradshteyn and I. M. Ryzhik, " Table of Integrals, Series, and Products " , 5th ed. New York:Academic, 1994.
- [37] M. K. Simon and M. – S. Alouini, " Digital Communications over Generalized Fading Channels:A Unified Approach to Performance Analysis " , Wiley, New York, 2000.
- [38] C. C. Tan and N. C. Beaulieu, " Infinite Series Representation of the Bivariate Rayleigh and Nakagami-m Distributions " , IEEE Trans. on Commun., Vol. 45, pp. 1159-1161, 1997.
- [39] P. G. Moschopoulos, " The Distribution of the Sum of Independent Gamma Random Variables " , Ann. Inst. Statist. Math. (Part A), Vol. 37, pp. 541-544, 1985.
- [40] M. – S. Alouini, A. Abdi, and M. Kaveh, " Sum of Gamma Variates and Performance of Wireless Communication Systems over Nakagami-Fading Channels " , IEEE Trans. on V. T., Vol. 50, No. 6, pp. 1471-1480, 2001.
- [41] P. Lombardo et al., " MRC Performance for Binary Signals in Nakagami Fading with General Branch Correlation " , IEEE Trans. on Commun., Vol. 47, No. 1, pp. 44-52, 1999.
- [42] M. Schwartz, W. R. Bennett, and S. Stein, " Communication Systems and Techniques " , McGraw-Hill: New York, 1966.
- [43] Z. Li, and M. Latva-aho, " Error Probability for MC-CDMA in Nakagami-m Fading Channels Using Equal Gain Combining " , IEEE International Conference , Vol. 1, pp. 227-231, 2002.
- [44] Z. Li, and M. Latva-aho, " Analysis of MRC Receivers for Asynchronous MC-CDMA with Channel Estimation Errors " , IEEE Seventh International Symposium Spread Spectrum Techniques and Applications, Vol. 2, pp. 343-347, 2002.
- [45] M. K. Simon and M. – S. Alouini, " A Unified Approach to the Performance Analysis of Digital Communication over Generalized Fading Channels " , Proc. of the IEEE, Vol. 86, pp. 1860-1877, 1998.