The Investigation of Arrangement Strategies in Base Station Antennas for the Multicarrier Coded-Division Spread-Spectrum

劉杰文、陳雍宗

E-mail: 211266@mail.dyu.edu.tw

ABSTRACT

In this thesis the investigation of an MC-CDMA (multi-carrier coded-division multiple access) system is constructed on the background of the OFDM techniques, where there are three different scenarios of antenna arrays considered to applied in this study, and they are including linear antenna array, triangular antenna array, and circular antenna array. Moreover, except the parameters of the correlated-fading channel are included, the frequency selective fading channel characterized by the correlated-Nakagami-m fading distribution is also adopted. In order to avoid the complex processing of the formulas for deriving the BER (bit error rate) performance of an MC-CDMA system, the complementary error function is adopted as the special function for evaluating the SNR (signal-to-noise ratio) at the output of the MRC (maximum ratio combining) diversity scheme. Furthermore, it is known that the more the received branch is at the output of the MRC, the better of the BER performance of an MC-CDMA system is. In the real world, the correlated-Nakagami-m distribution can be utilized to as the fading model for calculating the system performance of an MC-CDMA system. Thus, there are some of the important factors are assumed in this thesis, for example, the number of the sub-carriers, the system parameters of the fading, the correlation coefficients etc.. The proposed issue involved in the thesis is a valuable experience and capable of the theoretical research and the reality implementation on the basis of the MC-CDMA system.

Keywords : circular antenna array、linear antenna array、MC-CDMA、MRC(maximum ratio combining)、triangular antenna array、Nakagami-m fadin

Table of Contents

REFERENCES

[1]J. Proakis, Digital Communications. New York: McGraw-Hill, 1989.

[2] T. Eng and L. B. Milstein, " Coherent DS-CDMA Performance in Nakagami Multipath Fading, " IEEE Trans. on Commun., Vol. 43, pp. 1134-1143, Mar. 1995.

[3] S. Kondo and L. B. Milstein, " On the Use of Multicarrier Direct Sequence Spread Spectrum Systems, " in Proc. IEEE MILCOM ' 93. Boston. MA, pp. 52-56, Oct. 1963.

[4] N. Yee, J. P. Linnartz, and G. Fettweis, " Multi-carrier CDMA in Indoor Wireless Radio, " in Proc. PIMRC ' 93, Yokohama, Japan, pp. D1.3.-1.5, Dec. 1993.

[5] L. -L. Yang, and L. Hanzo, " Multicarrier DS-CDMA: A Multiple Access Scheme for Ubiquitous Broadband Wireless Communications, " IEEE Commun. Mag., pp. 116-124, Oct. 2003.

[6] S. Kondo, and L. B. Milstein, " Performance of Multicarrier DS-CDMA System, " IEEE Trans. on Commun., Vol. 44, pp. 238-246, Feb. 1996.

[7] J. Luo, J. Zeidler, and J. Proakis, " Error probability Performance for W-CDMA Systems with Multiple Transmit and Receive Antennas in Correlated Nakagami Fading Channels, " IEEE Trans. on Veh. Tech., Vol.51, no.6, pp. 1502-1516, Dec. 2002.

[8]E. K. Al-Hussaini and A. A. Al-Bassiouni, " Performance of MRC Diversity Systems for the Detection of Signals with Nakagami Fading, " IEEE Trans. on Commun., Vol. COM-33, pp. 1315-1319, Dec. 1985.

[9] W. C. Lee, Mobile Communications: Design Fundamentals, 2nd Ed., New York: Wiley, pp. 202-211, 1933.

[10]M. Nakagami, The m-distribution A General Formula of Intensity Distribution of Rapid Fading, in Statistical Methods in Radio Wave Propagation. Oxford, U. K.: Pergamon, pp. 3-36, 1960 [11]W. C. Y. Lee, " A Study of Antenna Array Configuration of an m-Branch Diversity Combining Mobile Radio Receiver, " IEEE Trans. on Commun. VT-20, pp. 93-104, 1971.

[12] R. K. Mallik and M. Z. Win, " A new Approach to the Performance Analysis of DS-CDMA Over Fading Channels, " in Proc. IEE Int. Conf. Personal Wireless Communications (ICPWC) 2002, pp. 300-304, Dec. 2002.

[13] T. Eng and L. Milstein, " Coherent DS-CDMA Performance in Nakagami Multipath Fading, " IEEE Trans. on Commun., Vol. 43, no. 3-4, pp.1134-1143, Feb./Apr. 1995.

[14] M. Pursley, " Performance Evaluation for Phase Coded Spread Spectrum Multiple Access Communication-Part I: System Analysis, " IEEE Trans. on Commun., Vol. COM-25, no.8, pp.795-799, Aug. 1977.

[15] G. Efthymoglou and V. A. Aalo, " Performance of RAKE Receivers in Nakagami Fading Channel with Arbitrary Fading Parameters, " Electron. Lett., Vol.31, pp.1610-1612, Aug. 1995.

[16] J. Luo, J. Zeidler, and J. Proakis, " Error Probability Performance for W-CDMA Systems with Multiple Transmit and Receive Antennas in Correlated Nakagami Fading Channels, " IEEE Trans. on Veh. Tech., Vol.51, no. 6, pp.1502-1516, Dec. 2002.

[17]I. S. Gradshteyn and I. M. Ryzhik, Table of Integrals, Series and Products, 5th Ed. San Diego, CA: Academic, 1994.

[18] V. A. Aalo, T. Piboongungon, and G. P. Efthymoglou, " Another Look at the Performance of MRC Schemes in Nakagami-m Fading Channels with Arbitrary Parameters, " IEEE Trans. on Commun., Vol. 53, Issue 12, pp. 2002-2005, Dec. 2005.

[19] H. M. Srivastava and H. L. Manocha, A Treatise on Generating Functions. New York: Wiley, 1984.

[20] H. Exton, Multiple Hypergeometric Functions and Applications. New York: Wiley, 1976.

[21] Kang Z., Yao K., " On the Performance of MC-CDMA over Frequency-selective Nakagami-m Fading Channels with Correlated and Independent Subcarriers, " In Proceeding of Globalcom, Vol. 5, pp. 2859-2863, 2004.

[22] Yang L. -L, Hanzo L., " Performance of Generalized Multicarrier DS-CDMA over Nakagami-m Fading Channels, " IEEE Transaction on Commun., Vol. 50, pp. 956-966, 2002.

[23]Chen J. I. -Z., " Performance Analysis of MC-CDMA Communication Systems over Nakagami-m Environments, " Journal of Marine Science and Technology, Vol. 14, no. 1, pp. 58-63, 2006.

[24] L. Rugini, P. Banelli, " BER of OFDM System Impaired by Carrier Frequency Offset in Multipath Fading Channels, " IEEE Trans. on Commun., Vol. 4, No. 5, pp. 2279-2288, Sep. 2005.

[25] Chen J. I. -Z., " Performance Analysis for an MC-CDMA System over Single- and Multiple-Cell Environments in Correlated-Nakagami-m Fading, " IEICE Trans. on Commun., Vol. E90-B, No. 7, pp. 1713-1724, July 2007.

[26] Liu X., Hanzo L., " Exact BER Analysis of OFDM Systems Communicating over Frequency-Selective Fading Channels Subjected to Carrier Frequency Offset, " IEEE Vehicular Technology Conference, VTC2007 spring, pp.1951-1955, Dublin, Ireland 22-25, April 2007.

[27] S. Bernard, " Digital Communications Fundamentals and Applications " , pp. 962-966, Prentice Hall International Inc., 2001.

[28] T. S. Rappaport, " Wireless Communications Principles and Practice " , prentice Hall PTR, New Jersey, 1996.

[29] B. Sklar, " Rayleigh Fading Channels in Mobile Digital Communication Systems Part 1: Characterization " , IEEE Commun. Magazine, pp. 90-100, July 1997 [30] Matthias Patzold, " Mobile Fading Channel " , Wiley, pp. 3-7, 2002.

[31]Rodney G. Vaughan and J. Bach Andersen, " Antenna Diversity in Mobile Communications, " in IEEE Transactions on Vehicular

Technology,Vol. VT-36,No. 4 Nov. 1987, pp. 149-172 [32] W. C. Jakes, Microwave Mobile Communications. New York: Wiley , 1974.
[33]L. Ahlin, " Coding methods for the mobile radio channel, " in Proc. Nordic Seminar on Digital Land Mobile Radiocomrnunications,Espoo, Finland, Feb. 1985, pp. 185-194.
[34] W. C. Y. Lee and Y. S. Yeh, " Polarization diversity system for mobile radio, " IEEE Trans. Commun., vol. COM-20, No. 5, 1972.
[34] W. C. Y. Lee and Y. S. Yeh, " Polarization diversity system for mobile radio, " IEEE Trans. Commun., vol. COM-20, No. 5, 1972.
[35] S. Kozono, H. Tsuruhata, and M. Sakamoto, " Base station polarization diversity reception for mobile radio, " IEEE Trans. Veh. Technol., vol. VT-33, No. 4, pp. 301-306, 1984.
[36] W. C. Lee, Mobile Communications: Design Fundamentals, 2nd ed. New York: Wiley, 1993, pp. 202 – 211.
[37] 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, July 1994.
[38] Zhengjiu Kang and Kung Yao, " Performance Comparison of MC-CDMA over Frequency-Selective Nakagami-m and Rayleigh Fading Channels " , Vehicular Technology Conference, Vol. 6, pp. 4228 – 4232, Sep. 2004.
[39] E. A. Sourour and M. Nakagami, " Performance of Orthogonal Multicarrier CDMA in a Multipath Fading Channel, " IEEE trans. on Commun., Vol. 44, pp. 356-367, Mar. 1996.
[40] T. Kim, Y. Kim, J. Park, K. Ko, S. Choi, C. Kang, and D. Hong, " Performance of an MC-CDMA System with Frequency Offsets in Correlated Fading " , IEEE International Conference on ICC 2000, Vol. 2, pp. 1095 – 1099, June 2000.
[41] J. Park, J. Kim, S. Choi, N. Cho, and D. Hong, " Performance of MC-CDMA Systems in Non-independent Rayleigh Fading " , IEEE on ICC ' 99, Vol. 1, pp. 506-510, 6-10 June 1999.
[42] Q. (Rock) Shi and M. Latva-aho, " Exact Error Floor for Downlink MC-CDMA with Maximal Ratio Combining in Correlated Nakagami Fading Channels " , 2002 International Zurich Seminar on Broadband Communications, pp. 37-1-37-5, 20 Feb. 2002.
[43] Z. Li, and M. Latva-aho, " Erroe Probability for MC-CDMA in Nakagami-m Fading Channels Using Equal Gain Combining " , IEEE International Conference on ICC 2002, Vol. 1, pp. 227 – 231, 28 April- 2 May 2002.
[44] Nakagami, M., " The m-Distribution-A General Formula of Intensity Distribution of Rapid Fading " , Statistic Methods of in Radio Wave Propagation, pp. 3-36, Pergamon Press, New York, 1960.
[45] M. – S. Alouini, A. Abdi, and M. Kaveth, " 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, Nov. 2001.
[46] Q. Shi and 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, Jun. 2003.
[47]M. Schwartz, W. R. Bennett, and S. Stein, " Communication Systems and Techniques " , McGraw-Hill: New York, 1966.
[48] I. S. Grodshteyn, and I. M. Ryzhik. Table of Integrals, series, and products, San Diego, CA: Acadenic Press, 5th Ed. 1994.
[49] W. C. Jakes, Microwave Mobile Communications, IEEE Press, Piscataway, Jersey, 1974 [50] J. Park, J. Kim, S. Choi, N. Cho, and D. Hong, " Performance of MC-CDMASystems in Non-independent Rayleigh Fading " , IEEE on ICC ' 99, Vol. 1, pp. 506-510, 6-10, June 1999.
[51] J. Zhou, S. Sasaki, S. Muramatsu, H. Kikuchi and Y. Onozato, " Saptial correlation for a circular antenna array and its applications in wireless communications, " IEEE Global Telcommunications Conference, Vol. 2, pp. 1108-1113, 2003.
[52] J. H. Winters, " Optimum combining in digital mobile radio with cochannel interference, " IEEE Trans. Veh. Technol., vol. VT-33, no.3, pp. 144-155, 1984.
[53] R. G. Vaughan, " Signals in mobile communications, A review, IEEE Trans. Veh. Technol., vol. VT-35, no. 4, pp. 133-145, 1986.
[54] Q. T. Zhang, " Maximal-Ratio Combining over Nakagami Fading Channels with an Arbitrary Branch Covariance Matrix " ,IEEE TRANSACTIONS ON VEHICULAR TECHNOLOGY, VOL. 48, NO. 4, JULY 1999 [55]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, July 1994.
[56]Zhengjiu Kang and Kung Yao, " Performance Comparison of MC-CDMA over Frequency-Selective Nakagami-m and Rayleigh Fading Channels " , Vehicular Technology Conference, Vol. 6, pp. 4228-4232, Sep. 2004.
[57]E. A. Sourour and M. Nakagami, " Performance of Orthogonal Multicarrier CDMA in a Multipath Fading Channel, " IEEE trans. on Commun., Vol. 44, pp. 356-367, Mar., 1996.
[58]T. Kim, Y. Kim, J. Park, K. Ko, S. Choi, C. Kang, and D. Hong, " Performanceof an MC-CDMA System with Frequency Offsets in Correlated Fading " , IEEE International Conference on ICC 2000, Vol. 2, pp. 1095-1099, June 2000.
[59]J. Park, J. Kim, S. Choi, N. Cho, and D. Hong, " Performance of MC-CDMA Systems in Non-independent Rayleigh Fading " , IEEE on ICC ' 99, Vol. 1, pp. 506-510, 6-10, June 1999.
[60]Q. (Rock) Shi and M. Latva-aho, " Exact Error Floor for Downlink MC-CDMA with Maximal Ratio Combining in Correlated Nakagami Fading Channels " , 2002 International Zurich Seminar on Broadband Communications, pp. 37-1-37-5, 20 Feb. 2002.
[61]Q. Shi and 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, Jun. 2003.
[62]Z. Li, and M. Latva-aho, " Erroe Probability for MC-CDMA in Nakagami-m Fading Channels Using Equal Gain Combining " , IEEE

International Conference on ICC 2002, Vol. 1, pp. 227-231, 28 April- 2 May 2002.
[63]Joy Iong-Zong Chen, and Chieh Wen Liou, “ On the Impact of ExponentMultipath and Branch Correlation on MC-CDMA System in Frequency-Selective Fading Environments, ” IAENG International Journal of ComputerScience, Vol. 33, Issue 1, pp. 86-91, March 2007.
[64]Joy Iong-Zong Chen, Chieh-Wen Liou, “ Performance Evaluation of MC-CDMA Systems with EGC Diversity over Correlated Selective Fading Channels, ” Proceeding of IEEE Wireless Communications and Networking Conference 2007, Proceeding of WCNC 2007,pp. 4186-4190, Hong Kong.
[65]Joy Iong-Zong Chen, Chieh Wen Liou, and Wen Sheng Tu , “ Applying the Correlated Gamma Statistics in Channel Capacity Evaluation for Dual-branchMRC Diversity over Correlated-fading Channels, ” 11th WSEAS International Conference on Communications Agios Nikolaos, Crete Island, Greece, pp. 173-177, July 23-28, 2007.
[66] 陳雍宗,劉杰文,胡永柟, “ Designing a Two-Dimensional(2D) Rake Receiver Scheme for an MC-CDMA System, ” Journal of Science And Engeering Technology, Vol. 4, Number 3, pp. 27-39, September 2008.
[67] Joy Iong-Zong Chen, Meng Tsun Hsieh,Chieh Wen Liou,and Hsuan-Yu Huang, ” Investigating to the CFO Phenomena for MC-CDMA System Combining with Multi-Dimension Receiver over Selective Fading, ” 2009 InternationalConference on Advanced Information Technologies, April 24-25 2009.