模糊理論應用於語音辨識系統上之研究與設計=a study and design of speech recoginition system by using fuzzy theory

劉杰文、胡永栴

E-mail: 8407566@mail.dyu.edu.tw

摘 要

本論文研究之主要目的乃是以獨立語音辨認系統為基本架構,應用模糊理 論設計一模糊推論器來做語音樣型比對,以期達到準確的辨認結果。本論 文中,首先在模糊推論器的設計上,找出特定語者發音的頻譜特徵 --共振 頻率(Formants)F1、F2及F3,將各個共振頻率做為模糊推論器的模糊元素, 以共振頻率的統計值訓練來規劃歸屬函數,接著模糊規則庫之建立則是以 監督式訓練加上個人自我認定來找出最佳之推論規則。最後做國語單母音 及雙母音之測試,將每次由模糊推論器推論出之解模糊化值以隨意法製作 成參考樣型,再以有限段數平均法分段方式做樣型比對,而以最接近法來做 辨認。經由分別對國語單母音及雙母音測試辨認率的模擬結果發現,辨認 率均可達95%以上。因此驗證了以模糊推論方式應用在語音辨認上的可行 性,同時也確認本研究理念之可行性。

關鍵詞 : 樣型比對、獨立語音辨認

目錄

參考文獻

[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 - 79 - 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 - 80 - 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, ” - 81 - 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 - 82 - 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. - 83 - 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. - 84 - [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. - 85 - [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. - 86 - [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 - 87 - 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.