A Study on Beam Pattern Generation Method for Antenna Array System

王元鈞、武維疆

E-mail: 9315099@mail.dyu.edu.tw

ABSTRACT

As more and more subscribers utilize wireless for communication and the vast amount of data, the loading is growing dramatically in today's cellular network. Hence, the most significant concern for network manager is system "Capacity". In this research, several factors that adversely affect system capacity in typical CDMA cellular network are extensively analyzed, including: (1).Unbalanced traffic load (2).Handoff overhead (3).Pilots interference Unfortunately, the conventional sectorized cellular structure cannot resolve the above problems. In what fallows, we provide a systematic study on several beam pattern generation algorithms in this research. In the first algorithm, the weights are derived to best approximate a desired array pattern either in a minimum-mean -square-error (MMSE) sense or by the consideration of several specific constraints. We have discribed several disadvantages of the first algorithm. In order to avoid these disadvantages, we develop the Spatial Sampling Mehtod that exploit the discrete Fourier transform (DFT) technique and the Windowing Method that based on the digital FIR filter design technique. Simulation results demonstrate that the generated beam pattern can be flexibly shaped, steered, and gain-controlled for practical requirements in each method. We demonstrate that shaping, steering, and gain-control for each beam can efficiently resolve the above-mentioned three problems.

Keywords : System capacity, Unbalanced traffic load, Handoff overhead, Pilots interference, Minimum-mean-square-error, Discrete Fourier transform (DFT), FIR filter.

Table of Contents

REFERENCES

[1]W.C. Wu, "Application of Smart Antenna Technology to Enhance CDMA System Capacity", -Proposal of NSC project NSC 91-2213-E-212-021.

[2]Joseph C. Liberti, JR and Theodore S. Rappaport. "Smart antennas for wireless commu -nications: IS-95 and Third Generation CDMA Applications," Chap 3. Prentice Hall PT -R, 1999.

[3]Chryssomallis, M., " Smart antennas", Antennas and Propagation Magazine, IEEE , Vo -l 42, pp 129-136, 3 , June 2000.

[4]R. J. Noll and S. H. Macomber."Analysis of Grating surface Emitting Laser" IEEE jou -rnal of quantum electronics. Vol. 26. NO. 3. march

1990.
[5]C. Y. Rew, S. B. Park and J. B. Ra."Elimination of all grating lobes in ultrasonic -synthetic focusing using a linear array" IEEE ELECTRONICS LETTERS 16th vol.29 No. - 19 September 1993.
[6]J. Warner." Array symmetry, beam patterns, and grating lobes" Electronically Scanne -d Antennas, IEE Colloquium on Pages:2/1 - 2/3 , 21 Jan 1988.
[7]Siachalou, E.; Vafiadis, E.; Goudos, S.S.; Samaras, T.; Koukourlis, C.S.; Panas, S., -" On the design of switched-beam wideband base stations",IEEE Transaction on Antenn -as and Propagation Magazine, Vol. 46, pp. 158-167, 1 , Feb. 2004.
[8]Bialkowski, M.E.; Karmakar, N.C.," A beamforming network for a compact circular swi -tched-beam array antenna" Microwave Conference, 1999 Asia Pacific, Vol. 3, pp. 869- -872, 30 Nov.-3 Dec. 1999.
[9]Lewis, R.A.H.; Perrott, R.A.," Multiple beam stripline network for phased array appl -ications", IEE Colloquium on Multiple Beam Antennas and Beamformers, pp. 4/1 - 4/5, - 21 Nov 1989.
[10]DuFort, E.C.," Optimum networks for simultaneous multiple beam antennas", IEEE Tran -sactions on Antennas and Propagation, Vol. 40, pp. 1-7, 1 , Jan. 1992.
[11]Zoltowski, M. "High resolution sensor array signal processing in the beamspace doma -in: novel techniques based on the poor resolution of Fourier beamforming" Spectrum - Estimation and Modeling., Fourth Annual ASSP Workshop on , 3-5, pp 350 - 355, Aug -. 1988 [12]Po-Rong Chang; Wen-Hao Yang; Kuan-Kin Chan.," A neural network approach to MVDR bea -mforming problem", IEEE Transactions on , Vol 40 , pp 313-322, 3 , March 1992.
[13]McWhirter, J.G.; Shepherd, T.J.," Systolic array processor for MVDR beamforming", I -EE Proceedings F , Vol 136, pp 75-80, 2 , April 1989.
[14]Haykin, S. (2002) "Adaptive Filter Theory.", pp 94-107. Prentice Hall. Upper saddle - River, New Jersey.
[15]Applebaum, S.; Chapman, D.," Adaptive arrays with main beam constraints", IEEE Tran -sactions on Antennas and Propagation, vol 24, pp 650-662, 5 , Sep 1976.
[16]B. P. Ng.,"Designing array patterns with optimal inter-element spacings and optimal - weights using a computer-aided approach,",Int. J. Electron., Vol. 73, no. 3, pp 6 -53-664, 1992.
[17]C.Y. Tseng, and L.J. Griffiths, "A simple algorithm to achieve desired patterns for - arbitrary arrays" IEEE Transations on Signal and Processing, vol.40, no. 11, pp. -2737-2746, Nov. 1992.
[18]Goto, N.," A synthesis of array antennas for high directivity and low sidelobes", I -EEE Transactions on Antennas and Propagation, Vol. 20, pp. 427-431, 4 , Jul 1972.
[19]Suzuki, Y.; Chiba, T.," An algorithm for pattern synthesis improvement", IEEE Trans -actions on Antennas and Propagation, Vol. 34, pp. 825-829, 6 , Jun 1986.
[20]Olen, C.A.; Compton, R.T., Jr.," A numerical pattern synthesis algorithm for array -s", IEEE Transactions on Antennas and Propagation, Vol. 38, pp. 1666-1676, 10 , Oc -t. 1990.
[21]Vanpoucke, F.; Moonen, M., "Systolic robust adaptive beamforming with an adjustable - constraint", IEEE Transactions on Aerospace and Electronic Systems , Vol 31, pp 6 -58-669, 2 , April 1995 [22]Elkamchouchi, H.M.; Adam, M.A.R.M.," A new constrained fast null steering algorithm" -, Antennas and Propagation Society International Symposium, IEEE , Vol 2 , 16-21, -pp 926-929, July [23]Lonnie C. Ludeman, "Fundamentals of Digtal Signal Processing", pp 263-264, Wiley, N -ew Mexico State University.,1986.
[24]Chen, X.P.; Yu, S.L.," FIR filter design: frequency-sampling method based on evolut -ionary programming", Proceedings of the 2000 Congress on Evolutionary Computation, - Vol. 1, pp. 575-579, 16-19 July 2000 [25]Allen V. Oppenheim and Ronald W. Schafer with John R. Buck, "Discrete-Time Signal P -rocessing", Chap 7, Prentice Hall, Upper saddle River, 1999.
[26]Smith, M.J.T., " A novel FIR filter design method based on windowing", IEEE Interna -tional Symposium on , Vol 1, pp 347-350, 8-11 May 1989.
[27]Van de Vegte Joice, "Fundamentals of Digital Signal Processing", pp 315-373. Prenti -ce Hall. Upper saddle River, New Jersey, 2002.
[28]Rosloniec, S.," A new approach to designing the transmission line band stop filters - for antenna arrays", 13th International Conference on Microwaves, Radar and Wirel -ess Communications, Vol. 1, pp. 69-73, 22-24 May 2000.
[29]Emmanuel C. Ifeachor;Barrie W.Jervis,"Digital Signal Processing A Practical Approac -h", pp.303-336, Addison-Wesley, 1993.
[30]Yuan-Pei Lin; Vaidyanathan, P.P.," A Kaiser window approach for the design of proto -type filters of cosine modulated filterbanks", IEEE Signal Processing Letters, Vol -. 5, pp. 132-134, 6 , June 1998