適應性波束形成器之硬體設計與模擬

陳世軒、劉仁俊

E-mail: 9019016@mail.dyu.edu.tw

摘 要

適應性波束形成技術的目的是用來獲得從不同方位抵達的信號資料，並估測各個信號源的入射角，藉著集中的運算來搜尋可靠的角度，使系統更有效率的運作。應用的範圍包括了雷達、聲納、語音和無線通訊等。MINIMUM VARIANCE DISTORTIONLESS RESPONSE (MVDR)是以基本的最佳濾波器和頻譜分析為出發點，以最佳化的演算法求出最小成本函數，亦即最佳權值，以得到陣列天線的輸出。反相關性矩陣的計算和導控向量的乘法運算是運算過程中最重要的一環。在需要高速的運算系統中，反矩陣的運算對處理器來說是一個龐大的負擔，尤其是在維度很高的環境中，且若矩陣接近奇異矩陣時更增加了運算的複雜度。所幸運算過程可採遞迴的方式，是一種適應性的法則，能夠有效率的執行運算。本論文將針對這些特性加以研究，推導出計算反相關性矩陣的快速法則，並將結果實際模擬應用於信號源的偵測上面。在硬體開發上，應用德州儀器公司所生產的TMS320C6X 之數位訊號處理器做為開發工具，來將整個適應性波束形成器的系統實現於數位訊號處理器之硬體工具上，使得適應性波數形成技術能更便利的與其它無線通訊發展技術相結合。

關鍵詞 : 線性陣列天線、環形陣列天線、MVDR、LCMV、相關性矩陣、遞迴最小平方、數位訊號處理

目錄

參考文獻

[1] T.E.CURTIS, "DIGITAL BEAM FORMING FOR SONAR SYSTEM," IEEE PROC. PT.F,VOL.127,PP. 257-265,AUG.1980.
[2] P.BARTON, "DIGITAL BEAMFORMING FOR RADAR," IEEE PROC. PT.F,VOL.127,PP.266-277,AUG. 1980.
[3] B. D. VAN VEEN AND K. M. BUCKLEY, "BEAMFORMING: A VERSATILE APPROACH TO SPATIAL FILTERING," IEEE ASSP MAGAZINE, PP. 4-924, APRIL 1988.
[4] H. KRIM AND M. VIBERG, "TWO DECADES OF ARRAY SIGNAL PROCESSING RESEARCH: THE PARAME -TRIC APPROACH," IEEE SIGNAL PROCESSING MAGAZINE, PP. 67-94, JULY 1996.
[5] J. CAPON, "HIGH-RESOLUTION FREQUENCY-WAVENUMBER SPECTRUM ANALYSIS," PROCEEDINGS OF IEEE, PP. 2408-2418, AUGUST 1969.
[6] S. HAYKIN, "ADAPTIVE FILTERING," 3RD ED., PRENTICE-HALL, 1996 [7] J.LITVA AND TITUS KWOK-YEUNG LO, "DIGITAL BEAMFIRMING IN WIRELESS COMMUNICATION", ARTECH-HOUSE,1996 [8] C. BALANIS, "ANTENNA THEORY, ANALYSIS AND DESIGN," JOHN WILEY & SONS, 1982.
[9] R. O. SCHMIDT, "A SIGNAL SUBSPACE APPROACH TO MULTIPLE EMITTER LOCATION AND SPECTRAL ESTIMATION," PH.D. DISSERTATION, STANFORD UNIVERSITY, 1981.
[10] R. ROY AND T. KAILATH, "ESPRIT - ESTIMATION OF SIGNAL PARAMETERS VIA ROTATIONAL INVARIANCE TECHNIQUES," IEEE TRANSACTIONS ON ASSP, VOL. 37, NO. 7, PP. 984-995, JULY, 1989.
[11] P. CHANG, W. YANG AND K. CHAN, "A NEURAL NETWORK APPROACH TO MVDR BEAMFORMING PROBLEM", IEEE TRANSACTIONS ON ANTENNA AND PROPAGATION, VOL. 40, NO. 3, PP. 313-321, MARCH 1992.
[12] G. H. GOLUB AND C. F. VAN LOAN, "MATRIX COMPUTATIONS," 2ND ED., JOHN HOPKINS UNIVER -SITY PRESS, 1989.
[13] W. PRESS, B. FLANNERY, S. TEUKOLSKY AND W. VETTERLING, "NUMERICAL RECIPES IN C," CAMBRIDGE UNIVERSITY PRESS, 1988.
[14] S.P. APPLEBAUM, "ADAPTIVE ARRAY," IEEE TRANS. ON AP,24,PP.585-598,1976 [15] R.WIDROW AND S. STEARNS. ADAPTIVE SIGNAL PROCESSING. ENGLEWOOD CLIFFS, NJ:PRETINCE -HALL,1985 [16] O.L. FROST III, "AN ALGORITHM FOR LINEARLY CONSTRAINED ADAPTIVE ARRAY PROCESSING," PROC. IEEE, VOL.60,PP.926-935,1972 [17] J.G.MCWHIRTER

AND T.J.SHEPHERD, "SYSTOLIC ARRAY PROCESSOR FOR MVDR BEAMFORMING," PROC INST. ELEC. ENG, VOL. 136, NO. 2,1989.
[18] W.M GENTLEMAN AND H.T. KUNG, "MATRIX TRIANGULARIZATION BY SYSTOLIC ARRAY," PROC SPIE REAL TIME SIGNAL PROCESSING IV, P.298,1981 [19] C.N. DORNY, "A VECTOR SPACE APPROACH TO MODELS AND OPTIMIZATION," WILEY-INTERSCIENCE, NEW YORK, 1975 [20] TMS320C6000 DSP/BIOS USER'S GUIDE(TI LITERATURE NUMBER : SPRU303) [21] TMS320C6000 DSP/BIOS APPLICATION PROGRAMMING INTERFACE (API) REFERENCE GUIDE(TI LITERATURE NUMBER : SPRU403) [22] TMS320C6000 PROGRAMMER'S GUIDE(TI LITERATURE NUMBER : SPRU198) [23] TMS320C6000 TECHNICAL BRIEF (TI LITERATURE NUMBER : SPRU197) [24] TMS320C6000 PERIPHERALS REFERENCE GUIDE (TI LITERATURE NUMBER : SPRU190) [25] TMS320C6000 OPTIMIZING COMPILER USER'S GUIDE (TI LITERATURE NUMBER : SPRU187) [26] TMS320C62C C SOURCE DEBUGGER USER'S GUIDE (TI LITERATURE NUMBER : SPRU188) [27] CODE COMPOSER STUDIO USER'S GUIDE(TI LITERATURE NUMBER : SPRU328) [28] TMS320C6000 CPU AND INSTRUCTION SET REFERENCE GUIDE(TI LITERATURE NUMBER : SPRU189) [29] HOW TO BEGIN DEVELOPMENT TODAY WITH THE TMS320C6211 DSP(TI LITERATURE NUMBER : SPRA474) [30] TMS320C6000 EMIF TO EXTERNAL ASYNCHRONOUS SRAM INTERFACE (TI LITERATURE NUMBER : SPRA542) [31] TMS320C6000 EMIF TO EXTERNAL FLASH MEMORY(TI LITERATURE NUMBER : SPRA568) [32] TMS320C6000 EMIF TO EXTERNAL SDRAM/SGRAM INTERFANCE0 (TI LITERATURE NUMBER : SPRA433A) [33] TMS320C6211 FIXED-POINT DIGITAL SIGNAL PROCESSOR(TI LITERATURE NUMBER : SPRS073A) [34] TMS320C6000 C COMPILER: DEVELOPMENT FLOW(TI LITERATURE NUMBER : SPRA518) [35] DSPBIOS BY DEGREES USING DSPBIOS FEATURES IN AN EXISTING APPLICATION (TI LITERATURE NUMBER : SPRA591) [36] IMPLEMENTATION OF AN ADAPTIVE ANTENNA(TI LITERATURE NUMBER : SPRA532) [37] TMS320C6000 EMIF: OVERVIEW OF SUPPORT OF HIGH PERFORMANCE MEMORY TECHNOLOGY(TI LITERATURE NUMBER : SPRA631) [38] USING DSP/BIOS I/O IN MULTICHANNEL SYSTEMS(TI LITERATURE NUMBER : SPRA689) [39] R. L. PETERSON, R. E. ZIEMER, AND D. E. BORTH "INTRODUCTION TO SPREAD SPECTRUM COMMUNICATIONS," 1995.
[40] R. STEELE "GSM, CDMAONE & 3G SYSTEM," 2000.
[41] IMPLEMENTING THE TMS320C6201/C6701/C6211 HPI BOOT PROCESS (TI LITERATURE NUMBER : SPRA512)