反覆式學習控制於液壓缸位置控制系統之研究

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摘 要

反覆式學習控制ILC(Iterative Learning Control)，即是經由反覆的操作過程中學習系統未知的資訊，以作為下次控制修正的經驗，因此ILC控制器能在有限的學習次數中，將系統跟隨誤差收斂至一微小的範圍內。本論文針對比例閥控單桿液壓缸，依傳統的系統分析方法推導其非線性數學模型，但實際系統的參數值不易確定，且不易以實驗求得，故無法直接引用作為控制器設計時所需之系統模式；因此本文以系統識別方法來估測系統之線性模式，並利用二維系統理論設計ILC控制器，對液壓系統進行位置跟隨控制。 在研究過程中分別以傳統的PID控制器及ILC控制器，進行液壓缸位置控制之模擬與實驗，並對此兩種控制器作分析與比較。由實驗結果顯示，ILC控制器可以有效的處理重複性的軌跡追蹤問題，特別是在傳統的控制方法無法妥善解決的暫態響應部份，有很好的改善效果，也因此在此應用上ILC之控制性能優於傳統的PID控制器。

關鍵詞 : 比例閥 ; 液壓缸 ; 反覆式學習控制 ; 二維系統 ; PID控制 ; 系統識別

目錄

參考文獻

[1]S. R. Lee and K. Srinivasan,“ Self-Tuning Control Application to Closed-Loop Servohydraulic Material Testing ”, Trans.ASME. J. of Dyn. Syst. Meas. Control, Vol.112 pp.681-689, 1990.

[2]J. S. Yun and H. S. Cho,“ Adaptive Model Follow Control of Electrohydraulic Velocity Control System Subject to Unknown Disturbance ”, IEE Proceeding Control Theory and Application, Vol.135, No.2, pp.149-156, 1988.

[3]J. S. Yun and H. S. Cho,“ Application of an Adaptive Model Follow Control Technique to a Hydraulic Servo System Subject to Unknown Disturbance ”, Trans.ASME. J. of Dyn. Syst. Meas. Control, Vol.113 pp.479-486, 1991.

[4]許毅然,“ 伺服油壓制動器位置適應控制研究 ”, 成功大學機械所碩士論文, 1988.

[5]J. Watton,“ A Digital Compensator Design for Electrohydraulic Singled-Rod Cylinder Position Control System ”, Trans.ASME. J. of Dyn. Syst. Meas. Control, Vol.112 pp.403-409, 1990.

[6]P. M. FitzSimons, J. J. Palazzolo,“ Part I: Modeling of a One Degree of Freedom Active Hydraulic Mount ”, Trans.ASME. J. of Dyn. Syst. Meas. Control, Vol.118 pp.439-442, 1996.

[7]覃俊龍,“ 回授位置控制下單桿液壓缸之非線性穩態及暫態反應 ”, 清華大學動機所碩士論文, 1990.

[8]許朝勝,“ 長行程單桿液壓缸於垂直負荷之位置伺服控制研究 ”, 成功大學機械所碩士論文, 1999.

[9]H. E. Merritt,“ Hydraulic Control System ”, John Wiley & Son, 1967.

[10]J. Watton,“ Fluid Power System, Modeling, Simulation, Analog & Micro-computer Computer Control ”, Prentice-Hall,1987.

[11]葉國安,“ 使用比例閥與伺服閥在液壓伺服定位控制上之比較 ”, 中原大學機械所碩士論文, 1995.

[12]陳元榮,“ 油壓電磁比例閥動態及控制之研究 ”, 中央大學機械所碩士論文, 1991.

[13]劉景民,“ 比例壓力閥的靜態及動態分析 ”, 清華大學動機所碩士論文, 1994.

[14]J. B. Gambel, N. D. Vaughan,“ The Modeling and Simulation of a Proportional Solenoid Valve ”, Trans.ASME. J. of Dyn. Syst. Meas. Control, Vol.118 pp.120-125, 1996.
[15]J. B. Gambel, N. D. Vaughan,“ Comparison of Sliding Mode Control with State Feedback and PID Control Applied to a Proportional Solenoid Valve ”, Trans.ASME. J. of Dyn. Syst. Meas. Control, Vol.118 pp.434-438, 1996.
[16]S. S. Arimoto, S. Kawamura and F. Miyazaki,“ Bettering Operation of Robots by Learning ”, J. of Robotic System, Vol.1, No.2, pp.123-140, 1984.
[17]K. L. Moore,“ Iterative Learning Control for Deterministic System ”, Advances in Industrial Control Series. Springer London.
[18]N. Amann, D. H. Owen and E. Roger,“ Iterative Learning Control for Discrete-Time System with Exponential Rate of Convergence ”, IEE Proceedings on Control Theory Applications, Vol.143, No.2, pp.217-224, 1996.
[19]N. Amann, D. H. Owen and E. Roger,“ Iterative Learning Control Using Optimal Feedback and feedforward Actions ”, Int. J. of Control, Vol.65, No.2, pp.277-293, 1996.
[20]J. E. Kurek and M. B. Zaremba,“ Iterative Learning Control Synthesis Based on 2-D System Theory ”, IEEE Trans. on Automatic Control, Vol.38, No.1, pp.121-125, 1993.
[21]Z. Geng, R. Carroll and J. Xie,“ Two-Dimensional Model and Algorithm Analysis for a Class of Iterative Learning Control System ”, Int. J. of Control, Vol.52, pp.833-862, 1990.
[22]Z. Geng, D. J. Lee, R. L. Carroll, L. H. Haynes“ Learning Control System Design Based on 2-D Theory—An Application to Parallel Link Manipulator ”, IEEE. J. of Robotics and Automation, Vol.6, No.2, pp.1510-1515, 1991.
[23]T. W. S. Chow and Y. Fang,“ An Iterative Learning Control Method for Continuous-Time System Based on 2-D System Theory ”, IEEE Trans. on Circuits Systems, Vol.45, No.4, pp.683-689, 1998.
[24]T. W. S. Chow and Y. Fang,“ Iterative Learning Control of Linear Discrete-Time Multivariable System ”, Automatica, Vol.34, No.11, pp.1459-1462, 1998.
[25]D. H. Hwang, S. R. Oh and Z. Bien,“ Iterative Learning Control Method for Discrete-Time Dynamic System ”, IEE Proceedings-D, Vol.138, No.2, pp.139-144, 1991.
[26]賴國雄,“ 基於二維系統理論的反覆式學習控制器設計 ”, 成功大學航太所碩士論文, 1994.
[27]D. W. Wang,“ A Simple Iterative Learning Controller for Manipulator with Flexible Joints ”, Automatica, Vol.31, No.9, pp.1341-1344, 1995.
[28]S. R. Oh, , Z. Bien and I. H. Suh,“ An Iterative Learning Control Method with Application for the Robot Manipulator ”, IEEE J. of Robotics and Automation, Vol.4, No.5, pp.508-514, 1988.
[29]A. D. Barton, P. L. Lewin, and D. J. Brown,“ Practical Implementation of a Real-Time Iterative Learning Position Controller ”, Int. J. of Control, Vol.73, No.10, pp.992-999, 2000.
[30]黃政森,“ 反覆學習控制於非限定動力系統之穩定性的理論與實驗 ”, 大同工學院機械所碩士論文, 1994.
[31]R. Roesser,“ A Discrete State-Space Model for Linear Image Processing ”, IEEE. Trans. on Automatic Control, Vol.AC-20, No.1, pp.1-10, 1975.
[32]T. Kaczorek,“ Two-Dimensional Linear System ”, Berlin: Springer- Verlag, 1985.
[33]W. S. Lu, E. B. Lee,“ Stability Analysis for Two-Dimensional System ”, IEEE. Trans. on Circuits and Systems, Vol.30, No.7, pp.455-461, 1983.