反覆式學習控制應用於氣壓X-Y平台之控制

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摘 要

反覆式學習控制(Iterative Learning Control, ILC)，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。本文將討論比例閥控氣壓X-Y平台系統之位置軌跡跟隨控制的實驗。在控制此系統時，同時加入不同型態之外界干擾，使系統參數會因外界干擾而有所變化，研究中採用反覆式學習控制法則，透過反覆的學習改善實驗中外界干擾的影響。我們運用P和PD-型態的學習控制法則，並加入延遲參數，控制X-Y平台作反覆軌跡追隨，達到收斂誤差之效果。另－方面，我們也使用預先儲存之最佳疊代控制信號，來與P和PD-型態之ILC控制法則比較，並分析在受到干擾情況下之收斂效果，實驗結果顯示在受干擾下，PD-型態比P-型態之ILC控制器來的好，可以有效的控制系統去跟隨預定的軌跡。

關鍵詞 : 比例閥，氣壓系統，反覆學習控制，二維系統，干擾

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參考文獻

[1]許正道, "油空壓的數位控制與應用", 全華科技, 民78.

[2]Mccloy,D. and Martin H.R., "Control of Fluid Power Analysis and Design ",2nd Edition, -1983.

[3]Junbo Song and Yoshihisa Ishida, "Robust tracking controller design for pneumatic ser -vo system", Int. J. Engng Sci., No 10/11 Vol. 35, pp. 905-920, 1997.

[4]Manukid Parnichkun and Charoen Ngaecharoenkul, "Kinematics control of a pneumatic sys -tem by hybrid fuzzy PID", Mechatronics, Vol. 11, pp.1001-1023, 2001.

[5]Sheng H. Chuang and C.Y.Du, "Representation and scheme for motion simulation of pneum -atic control circuits", Simulation Practice Theory, Vol.3, pp.365-381, 1996.

[6]Uchiyama, M., "Formation of High-speed Motion Pattern of amechanical arm by trial", T -rans. SICE(Society for Implementation and Control Engineers(in Japanese)), Vol. 14, -pp. 706-712,1978.

[7]S. S. Arimoto, S. Kawamura and F. Miyazaki, "Bettering Operation of Robots by Learnin -g", J. of Robotic System, Vol.1, No.2, pp.123-140, 1984.

[8]K. L. Moore, "Iterative Learning Control for Deterministic System", Advances in Indus -trial Control Series. Springer London.

[9]N. Amann, D. H. Owen and E. Roger, "Iterative Learning Control for Discrete-Time Syst -em with Exponential Rate of Convergence", IEEE Proceedings on Control Theory Applica -tions, Vol.143, No.2, pp.217-224, 1996.

[10]J. E. Kurek and M. B. Zaremba, "Iterative Learning Control Synthesis Based on 2-D Sy -stem Theory", IEEE Trans. on Automatic Control, Vol.38, No.1, pp.121-125, 1993.

[11]Z. Geng, D. J. Lee, R. L. Carroll, L. H. Haynes "Learning Control System Design Base -d on 2-D Theory—An Application to Parallel Link Manipulator", IEEE. J. of Robotics - and Automation, Vol.6, No.2, pp.1510-1515, 1991.

[12]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.

[13]T. W. S. Chow and Y. Fang, "Iterative Learning Control of Linear Discrete-Time Multi -variable System", Automatica, Vol.34, No.11, pp.1459-1462, 1998.

[14]D. H. Hwang, S. R. Oh and Z. Bien, "Iterative Learning Control Method for Discrete-T -ime Dynamic System", IEE Proceedings-D, Vol.138, No.2, pp.139-144, 1991.
[15]溫孝元, "離散型反覆式學習控制器之設計與實現", 華梵機電工程所碩士論文, 2000.
[16]林義鈞, "離散線性系統反覆式學習控制", 成功大學航太工程研究所碩士論文, 2003 [17]D. W. Wang, "A Simple Iterative Learning Controller for Manipulator with Flexible Jo -ints", Automatica, Vol.31, No.9, pp.1341-1344, 1995.
[18]S. R. Oh, , Z. Bien and I. H. Suh, "An Iterative Learning Control Method with Applic -ation for the Robot Manipulator", IEEE J. of Robotics and Automation, Vol.4, No.5, -pp.508-514, 1988.
[19]曾偉誠, "反覆式學習控制於液壓缸位置控制系統之研究", 大葉大學機械所碩士論文, 2001.
[20]Sanville,F.E, "A new method of specifying the flow capacity of pneumatic fluid power - values", 2nd International Fluid Power Symposium, B.H.R.A.,Cranfield, January, 1971.
[21]鄭瑋榮, "利用ADAMS分析引擎運轉對摩托車車架震動之影響", 屏東科技大學機械所碩士論文, 19 -99.
[22]Phadke, M. S, " Quality Engineering Using Robust Design", PTR Prentice-Hall Inc., 198 -9.
[23]Peace, G. S., " Taguchi Methods: A Hands-on Approach", Addison -Wesley Publishing Company, 1993.
[24]陳榮盛、陳界文、梁智翔, "以田口法實驗計劃法分析PU+金雲母材質用於射出成形加工之製程" -，力學期刊，第十二卷，第二期，第243-253 頁，1996。
[25]Lee, Y. , and Dziuba, J. C. J., and Lum, M. W, "Vehicle DesignProcess Using DOE," In -ternational Journal of Vehicle Design, Vol.17, No.1, pp.40-54., 1996.
[26]Liu, T.S., and Hsiao, I.H., "The Taguchi Method Application to Motorcycle Handling," - International Journal of Vehicle Design, Vol.12, No.3, pp.345-356, 1991.
[27]Dohi, M., and Maruyama, Y., "Ride Comfort Optimization for Commercial Trucks ," Society of Automotive Engineers Paper 902266, pp.890-902, 1990.