類神經網路於非線性程序系統控制之應用

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摘 要

模式預測控制(model predictive control, MPC)已成為最常用的程序控制架構之一，其原理係在控制器內建立一組程序模式，由模式來預測程序的響應。而藉由此模式來決定未來長期的操作值，使得未來響應與設定值間的差達到最小，也因此發揮控制效果。以往MPC中常使用的是一個線性化模式，對真實程序必然存在一定的誤差。然而，目前很多複雜的程序，多以神經網路(artificial neural network, ANN)來建立MPC中的預測模式，除了因為神經網路能做為良好的非線性模式外，主要更由於其擁有學習的能力，可由線上資料來決定網路中的權值，進而獲得正確的程序動態。以往，這類的神經預測控制(neural predictive control, NPC)，大都將ANN學習成一個ARX (AutoRegressive model with eXogenous)或ARMAX模式，因此，當需要長時間預測時，預測的結果需要以ANN迭代產生出來，故而誤差較大，且需要較長的運算時間。為改善上述缺點，本研究根據DMC(dynamic matrix control)的控制原理，以ANN學習摺合 (convolution) 模式。我們稱此種控制為神經網路預測控制(neural network predictive control, NNPC)。而基於ANN的學習方式與用途，研究中設計了一種以PRBS(pseudo random binary sequence)信號識別程序動態的方法，由這種識別的結果產生ANN學習所需的樣本。而在決定未來的操作時，則以Levenberg-Marquardt法依經過學習的ANN模式使得模式輸出與設定點的誤差最小化。 針對這新設計的控制器，我們以一個CSTR反應器進行測試。對溫度及濃度二個環路分別控制，結果顯示，無論是設定點或程序的干擾，NNPC都有很好的效果。當進一步，應用在一個動態緩慢的生化反應器程序時，由於ANN模式內節點的增加，造成網路學習時的困難。這時，我們減少預測模式中，操作與響應的次數。在這種簡化的模式預測控制器(simplified neural network predictive control, SNNPC)下，使得ANN更容易學習程序的動態。在和傳統PI及DMC控制器比較後，顯示這種控制器仍然維持著相當不錯的控制品質，但偏移(off-set)卻明顯地增加。

關鍵詞 : 神經網路 ; 模式預測控制 ; 簡化神經網路模式預測控制

目錄

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