ABSTRACT

Intelligent Optimal Non-Linear Control

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A weightless sparse distributed neural network architecture is the basis of two types of networks. Classification type networks and function approximation type networks. The former is required in system identification and the latter for modelling and control. Incremental learning is performed using adaptive gain modulated recursive linear regression on experimental data with regression parameters stored by network components. For classification problems zero order regression is sufficient. For modelling problems first and higher order regression may be used. First order regression produces isotropic linear models of the non-linear process for which linear quadratic regulation can be used for optimal control.
The intelligent controller described is capable of learning incrementally the discrete non-linear dynamics of an unknown process using experimental data, which it can use to predict the behaviour of the process for given inputs and known state. It is capable of identifying previously learnt dynamics given incomplete experimental data and subsequently given a set point, performance requirements and the states of the process for each time step can determine the control input required for optimum performance. Design guidelines are developed based on the distribution of the input space that the network represents which has been found to be Gamma distributed with Normal approximation for higher dimensions. For high dimensions the space was found to be quantized, forming crisp sets. For lower dimensions fuzzy sets are described naturally with membership of remarkable resemblance to Gaussian Bell functions and therefore the rudiments of language.
Experimental results on several non-linear discrete dynamic systems validated expectations based on theoretical considerations in the development of the method described in the thesis.

Keywords: weightless; intelligent; optimal; non-linear; sparse; distributed.