On the Robust Control of Nonlinear Systems using Dynamic Neural Network (DNN)

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The applications of Dynamic Neural Network (especially the Hopfield Neural Network, HNN) have been mainly in the area of pattern recognition since 1982. The DNN is actually a nonlinear dynamical system which possess several stable states, which are the so called "associative memories" to represent the recognized states. However it has received limited successes in recognizing a simple black and white image, not to mention the grey images. This is true even with the explosive developments of Cellular Neural Network (CNN) to simplify the hardwired connections. This limited success of applying DNN in pattern recognition has led us to think the direct applications of DNN for the robust control of nonlinear dynamical systems.

The HNN will be treated as a direct (or indirect) adaptive controller for the robust control of nonlinear dynamical systems. A new Lyapunov stability analysis will be adopted to adjust the weighting factors in HNN by solving a simple nonlinear differential equation of weighting factor. Several simulation studies of nonlinear systems have been conducted to show the effectiveness of this new approach. In comparison with the robust control using a feed-forward static Fuzzy Neural Network (FNN), this new approach does not require the uncertain fuzzy rules with its de-fuzzification process. Therefore real-time coding is simplified which will reduce the cost of hardware platform for the real world implementations of HNN robust controller. Therefore the industrial impact of this new approach will be the feasibility of cheaper hardware implementation to reduce the cost of building intelligent control systems using this innovative approach, i.e., the robust control of robotic arm, inverted pendulum, chaotic systems, …, etc.