Recurrent neural networks are discussed for real-time inverse kinematic control of redundant manipulators. Three recurrent neural network models, the Lagrangian neural network, the primal-dual neural network, and the dual neural network. We begin with the Lagrangian neural network for the inverse kinematics computation based on the Euclidean norm of the joint velocities to show the feasibility. Next, we present the primal-dual neural network for minimum infinity norm kinematic control of redundant manipulators. To reduce the model complexity and increase the computational efficiency, the dual neural network is developed with the advantages of simple architecture and exponential convergence. Simulation results based on the PA10 robot manipulator substantiate the effectiveness of the present recurrent neural network approach.

Keywords: kinematically redundant manipulators, recurrent neural networks, inverse kinematics.

1 Introduction

Kinematically redundant manipulators are those having more degrees of freedom than required to perform manipulator given tasks. The redundancy of such manipulators includes intrinsical redundancy and functional redundancy [1]. The use of kinematically redundant manipulators is expected to increase dramatically in the future because of their ability to avoid obstacles, joint limits, and singularities, and to optimize various performance criteria, while conducting the end-effector motion task.

The real-time computation of inverse kinematics solutions is very time-consuming in high degree-of-freedom sensor-based robotic systems, especially for the case when multiple performance criteria and/or dynamic physical constraints are considered, due to the time-varying nature and the real-time calculation requirement. Parallel computation methods such as neural network approaches are effective and efficient alternatives for inverse kinematics solu-