Primitive Manipulation Learning with Connectionism

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Abstract

Infants' manipulative exploratory behavior within the environment is a vehicle of cognitive stimulation[McCall 1974]. During this time, infants practice and perfect sensorimotor patterns that become behavioral modules which will be seriated and imbedded in more complex actions. This paper explores the development of such primitive learning systems using an embodied light-weight hand which will be used for a humanoid being developed at the MIT Artificial Intelligence Laboratory[Brooks and Stein 1993]. Primitive grasping procedures are learned from sensory inputs using a connectionist reinforcement algorithm while two submodules preprocess sensory data to recognize the hardness of objects and detect shear using competitive learning and back-propagation algorithm strategies, respectively. This system is not only consistent and quick during the initial learning stage, but also adaptable to new situations after training is completed.

1 INTRODUCTION

Learning manipulation in an unpredictable, changing environment is a complex task. It requires a nonlinear controller to respond in a nonlinear system that contains a significant amount of sensory inputs and noise[Miller, et al 1990]. Investigating the human manipulation learning system and implementing it in a physical system has not been done due to its complexity and too many unknown parameters. Conventional adaptive control theory assumes too many parameters that are constantly changing in a real environment [Sutton, et al 1991, Williams 1988]. For an embodied hand, even the simplest form of learning process requires a more intelligent control network. Wiener [Wiener 1948] has proposed the idea of "Connectionism", which suggests that a muscle is controlled by affecting the gain of the "efferent-