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THE SELF-ORGANIZING ADAPTIVE CONTROLLER

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Abstract. *Humans have high flexibility in responding to changes in the environment, and show appropriate behavior in these circumstances. This paper presents a novel adaptive controller, called the Self-Organizing Adaptive Controller (SOAC), which is characterized by being highly adaptive as well as having a high generalization ability. The scheme proposed herein consists of a modular architecture, in which each module has a predictor/controller pair, and the competition between each module is undertaken in a self-organizing manner. Thus, the SOAC also has the ability to create a self-organizing map reflecting the differences between systems. Our simulation study has confirmed the effectiveness of the method using the SOAC compared with conventional ones. In particular, our method performs well, even when dealing with unknown objects that are not used in the learning. In addition, the present SOAC method has successfully been applied to stabilizing and controlling an inverted pendulum. Furthermore, visualization is made possible in terms of the relevant physical parameters.*

Keywords: Self-organizing map, mnSOM, Adaptive control, Feedback-error-learning, Inverted pendulum

1. **Introduction.** Humans have high flexibility in responding to changes in the environment and show appropriate behavior in these circumstances, i.e., humans have high adaptability and generalization. This paper outlines a first attempt in this direction by introducing a method that provides: (1) a quick response to sudden changes in a controlled object, and (2) the acquisition of general behavior from a small number of training patterns.

In dealing with complex objects, it is difficult for a single network (e.g., a multi-layer perceptron) to correspond. Therefore, more extensive architectures are needed. One of the more realistic solutions is to use a multiple model consisting of a number of neural network modules, which can each be switched in response to the condition of the controlled object. Consequently, several architectures using multiple models have been proposed by several researchers. For example, the mixtures of experts proposed by Jacobs et al. is a conventional modular architecture that consists of several expert networks and a gating network [1]. Narendra et al. [2, 3] proposed a multiple model, in which each module consists of a predictor and controller pair. In addition, Wolpert and Kawato proposed multiple paired forward-inverse models (MPFIM) that also adopt a predictor and controller pair [4]. Other neural network based multiple models have also been proposed, such as [5, 6].