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MULTIMODAL SENSORY MOTOR COORDINATION BY LEARNING IN DYNAMICAL SELF-ORGANIZING RELATIONSHIP NETWORK

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Abstract. *Action learning of autonomous robots is an important issue for development of complex robot systems. In the learning, robots learn by sensory motor coordination. The difficulties of this issue are that they should learn by trial-and-error and that they should adapt their actions to changes of environments. Foveation, which is to move their body and their sensors in order to capture a target object on the center of the visual field, is an essential example of the sensory motor coordination. Although several learning methods have been proposed for autonomous foveation learning, these have several crucial problems of efficiency and adaptability. In order to overcome these problems, in this paper, we propose a new learning method called Dynamical Self-Organizing Relationship Network (DSOR). It can learn an input/output relationship between multiple sensory information and motor action by trial-and-error, and acts as a knowledge acquisition tool and also as a fuzzy inference engine. It can also adapt to the dynamic change of I/O relationship. We examine the DSOR by applying it to a foveation learning problem in the computer simulation.*

Keywords: Multimodal sensor fusion, Sensory motor coordination, Dynamical self-organizing relationship network (DSOR), Adaptation, Evaluation, Fuzzy inference, Trial-and-error, Foveation, Sound localization, Knowledge acquisition

1. **Introduction.** There have been many efforts to apply excellent learning abilities of human brain to robot systems. In particular, action learning of autonomous robots by using sensory motor coordination is a very important and challenging issue, because the solutions of the issue enable the efficient development of complex robot systems. "Looking at an object" is a very simple example [1] and also an essential example of the issue. Moving the head and the eyes to capture the target object on the fovea, which is the high resolution center of retina, is called "foveation" [1]. The foveation can be carried out accurately for the target object at the back as well as at the visual field. This brilliant ability is realized by two different senses that are a visual sense and an auditory sense. It is also applicable to robotics, where the following points should be considered:

(1) Supervising data unavailable automatically
The robot can obtain the learning data only by trial and error.
(2) Multimodal sensory information necessary for robot learning
A single sensor modality is not enough to acquire the foveation ability for the entire field around the robot.
(3) Adaptability of learning method to problem changes
We can easily meet the changes of the problem, practically the changes of the robot