International Congress Series 1301 (2007) 197–200

www.ics-elsevier.com

Adaptability of mnSOM-based control system to changing dynamic property

Shuhei Nishida [a,*], Kazuo Ishii [b], Tetsuo Furukawa [b]

[a] *The University of Kitakyushu, Japan*
[b] *Kyushu Institute of Technology, Japan*

Abstract. Autonomous underwater vehicles (AUVs) are attractive tools for surveying earth science and for oceanography. However, many problems must first be solved. In order to realize useful and practical robots, underwater vehicles should take their action by judging the changing condition from their own sensors and actuators, and should make their behavior adaptable to the working environments. We have investigated the application of brain-inspired technologies, such as neural networks (NNs) and self-organizing map (SOM), into AUVs. In order to obtain the I/O relationships, such as dynamics and controller of AUVs, it is suitable to use NNs, which are trained by a supervised learning algorithm. An unsupervised learning algorithm that automatically recognizes the environment surrounding a robot is needed for a decision-making system. The objective of this research is to make a new self-organizing decision-making system for AUVs using the modular network SOM (mnSOM) proposed by Tokunaga et al. We have proposed a controller system for the AUV using mnSOM, and we have introduced the Forward Model Map, which expresses the relationship of control force and states variables of robots. In this paper, the adaptability of the proposed controller system is investigated through the simulations. © 2007 Published by Elsevier B.V.

Keywords: AUV; Adaptive Control; mnSOM

1. Introduction

Autonomous underwater vehicles (AUVs) are attractive tools for the maintenance of underwater structures and oceanography. However, there are various problems to solve, such as motion control, acquisition of sensor data, decision-making, navigation without

* Corresponding author. 1-1 Hibikino, Wakamatsu, Kitakyushu, Fukuoka, 808-0135, Japan. Tel.: +81 93 695 3710; fax: +81 93 695 3394.
E-mail address: nishida@env.kitakyu-u.ac.jp (S. Nishida).

0531-5131/ © 2007 Published by Elsevier B.V.
doi:10.1016/j.ics.2006.12.028

collision, and self-localization. In order to realize useful and practical robots, underwater vehicles should take their action by judging changing conditions from their own sensors and actuators, and should make their behavior adaptable to the working environments. We have investigated the application of brain-inspired technologies such as neural networks (NNs) and self-organizing map (SOM) [1] to AUVs [2,3]. The motion of AUV is represented by complicated non-linear dynamics in six degrees of freedom with added-mass and hydrodynamic forces, and control systems should be adaptive and robust. In our previous adaptive control method using NNs, time series of state variables and control signals were fed into the control system in order to adapt to the change of dynamic property and environment. Therefore, the amount of obtained information in the previous adaptation gradually decreases. If the environment of the robot has rapidly changed, the previous control system takes time to adapt to the new environment, and correct information on the former environment does not remain. Therefore, a new method, which keeps the information of the initial state or previous environment and adapts to the new environment, should be developed to improve the efficiency of the learning and to reduce the learning cost with the use of the former environmental information, which the robot had already learned. The objective of this research is to make a new self-organizing decision-making system for AUVs using the modular network self-organizing map (mnSOM) proposed by Tokunaga et al. [4]. We have proposed a new AUV controller system using mnSOM, and have reported the efficacy of the forward model map (FMM), which expresses the relationship of control force and states variables of robots [5]. In this paper, the adaptability of the proposed controller system is investigated through the simulations.

2. Controller system using mnSOM

The controller of the robot represents a recurrent neural network (RNN). The adaptive controller is realized using RNN-mnSOMs. The algorithm of the proposed control system

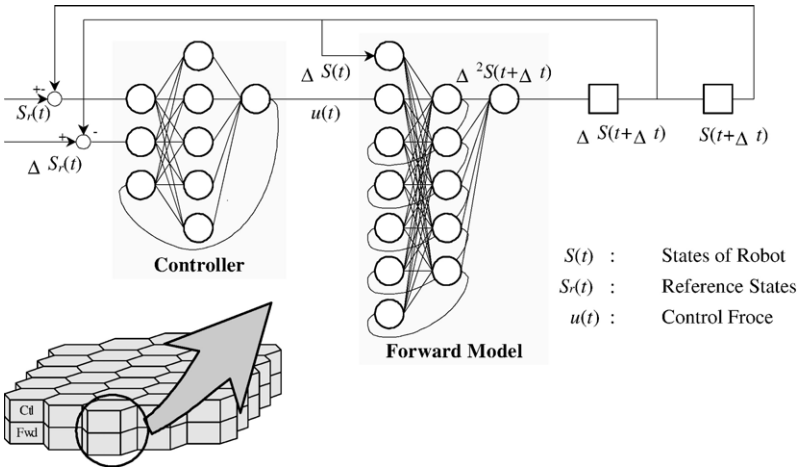

Fig. 1. Architecture of controller optimization with forward model.