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NEURAL DYNAMICS AND COMPUTATION FOR REAL-TIME MAP BUILDING AND PATH PLANNING OF MOBILE ROBOTS

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Abstract. A novel neural dynamics based approach is proposed for real-time simultaneous map building and path planning with limited measurable sensor information in a nonstationary environment. The dynamics of each neuron in the topologically organized neural network is characterized by a shunting or additive neural model with both excitatory and inhibitory connections and with only local connections among neurons. The environment is assumed to be completely unknown, and subject to arbitrary changes. The map of the environment is built during the real-time robot navigation through its sensor measurements that are limited to a short range. The real-time robot path is generated through the dynamic activity landscape of the neural network. The system stability is guaranteed by a Lyapunov stability theory. The effectiveness and the efficiency of the proposed approach are demonstrated by simulations studies.

Keywords: neural dynamics, map building, path planning, real-time navigation, Lyapunov stability, mobile robots

AMS (MOS) subject classification:

1 Introduction

Real-time collision-free path planning in a nonstationary environment is a very important issue in robotics. There are many studies on the path planning for robots using various approaches (e.g., [1]-[9]). Some of the early models deal with static environment only; some may suffer from undesired local minima (e.g., [1]-[3]). Several neural network models were proposed to generate real-time trajectory through learning. For example, Zalama *et al.* [4] proposed a neural network model for the navigation of a mobile robot, which can generate dynamic trajectory with obstacle avoidance through unsupervised learning [5]. However, the performance of learning based approaches are not consistent. Glasius *et al.* [6] proposed a neural network model for real-time collision-free trajectory formation in a nonstationary environment. However, this model suffers from slow dynamics and cannot perform properly in a fast changing environment [6]. Inspired by Hodgkin and Huxley's membrane model for a biological neural system and the later developed Grossberg's shunting model [11], Yang and Meng [7] proposed a neural network