Robotics, Artificial Intelligence and Embedded Systems

Master/Bachelor Thesis - Semester Project

Rewiring the CPG controller during rat robot error behaviors

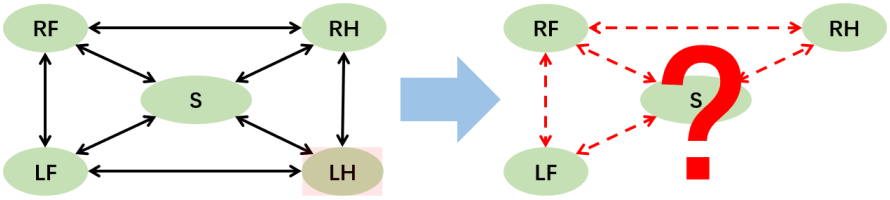

Figure 1 Schematic for CPG rewiring.

Background

By defining the mutual constraints between neurons in neural circuits, central pattern generators (CPGs) enable animals to continuously perform rhythmic movements without brain intervention [1]. Leveraging this characteristic, CPGs have been shown to optimize robot gait coordination and facilitate smooth gait transitions [2]. However, when a neuron within the CPG network fails, the neural circuit, based on its inherent constraint relationships, hard to achieve the pre-defined rhythmic movements. In this case, it becomes necessary to reconstruct the CPG network to regenerate rhythmic movements that achieve similar effects, as shown in **Figure 1**. Consequently, this research focuses on autonomously using CPG-rewiring to regenerate the rhythmic movements of robots when unrepairable errors occur during motion, allowing them to continue performing their tasks.

Your Tasks

In this thesis, your task will involve acquiring advanced knowledge of Central Pattern Generator (CPG) controllers and subsequently developing a rewirable CPG controller for a rat robot with spinal neurons. Specifically, you will:

1. Learn the fundamental principles and applications of CPG controllers in quadruped robots. It is recommended to utilize online materials, such as research papers [3].
2. Reproduce the results from existing research on CPG rewiring for smooth gait transitions [4].
3. Select one of the proposed ideas and investigate a novel algorithm for CPG rewiring to control the rat robot.

Requirements

High self-motivation; Over Six month working time; Python programming experiences.

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Reference

[1] Ijspeert, A.J., Crespi, A., Ryczko, D. and Cabelguen, J.M., 2007. From swimming to walking with a salamander robot driven by a spinal cord model. science, 315(5817), pp.1416-1420.

[2] Katz, P.S., 2016. Evolution of central pattern generators and rhythmic behaviours. Philosophical Transactions of the Royal Society B: Biological Sciences, 371(1685), p.20150057.

[3]Ijspeert, A.J., 2008. Central pattern generators for locomotion control in animals and robots: a review. Neural networks, 21(4), pp.642-653.

[4] Liu, C., Chen, Y., Zhang, J. and Chen, Q., 2009, October. CPG driven locomotion control of quadruped robot. In 2009 IEEE International Conference on Systems, Man and Cybernetics (pp. 2368-2373). IEEE.