In Vitro Logicality for Neuro-Robot Hybrid

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Rat hippocampal neurons are organized into complex networks in a culture dish with 64 planar microelectrodes. Multi-site recording system for extracellular action potentials is used for recording the activity of living neuronal networks and for applying input from the outer world to the network. The living neuronal network is able to express several patterns independently, and that's meaning that it has fundamental mechanisms for intelligent information processing.

In this paper, we propose a significant algorithm to analyze logicality and connectivity of electrodes in a culture dish [1], and show the neuro-robot hybrid [2] we developed. First, we discuss how to extract the logicality from living neuronal network in vitro with fuzzy *t-norm* and *t-conorm* operators. By the result of an experiment in which the parameter of fuzzy operator converged to infinity value, we concluded that a pulse at the 60th channel (60el) propagates to the spreading area, (51el, 59el), (43el, 50el), and (35el, 42el), and the logicality between the electrodes was shifted to the logical sum from the drastic product. Therefore, the logicality of electrodes became to drastically change to the weak OR relation from the strong AND relation when a crowd of the pulses was fired.

Next, we control a robot by describing several characteristic of living neuronal network in fuzzy rules. We call it "fuzzy bio-interface". We show a robot system controlled by a living neuronal network and fuzzy bio-interface. Fuzzy bio-interface consists of two kinds of fuzzy logic to translate stimulus of living neuronal network from sensor signal of robot, and control action of robot from response of living neuronal network. We estimated the learning of living neuronal networks with an example of straight running with neuro-robot hybrid. The completed courses of robot were 16 times among 20 trials, and the case of the robot crashed on the wall and stopped were four times. From the results, we conclude that the logicality of neuronal networks and the adaptability of the fuzzy interface work efficiently. We should conclude that the correct rate of 80% is extremely high because of living neuronal networks.

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