Abstract of Main Thesis

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Title of Thesis

CPG-based Neural Controller for Serpentine Locomotion of a Snake-like Robot

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Abstract on the Content of the Applicant's Thesis

Even though snakes have elongated and limbless bodies, they can move nimbly on rough ground with various gait patterns. By studying the mechanism of snake motion, these advantageous characteristics can be applied to a snakelike robot. The highly-redundant structure of the snake-like robot and the large degrees of freedom (DOFs) make the control of the robot have many difficulties. A decentralized control method based on the use of simple oscillation generators and on the coordination between them has been attracting a lot of attention. This control methodology is inspired from the nervous systems of animals in rhythmic motions, which is called the central pattern generator (CPG).

In this study, a bio-inspired CPG-based neural controller is proposed for the snake robot based on the nonlinear neural model. It can imitate the rhythmic swing of snake joints by use of entrainment caused by inter-CPG interaction and sensory input from the musculoskeletal system. Based on the analysis of the CPG model, the mathematical relationship between the parameters and rhythmic output were investigated. A desired serpentine locomotion of the snake robot can be performed with the parameter modulation of the CPG-based oscillator network.

The neural controller can achieve self-adaptive locomotion by tightly coupling sensory information to the corresponding body action, without necessarily the intervention of an elaborate world model. By integrating the sensory feedback signals, an adaptive motion control of the snake-like robot was analyzed. With the help of the neural network approach, the control system can combine the motion and environmental information, and evolve to an automatically optimal configuration on its own. This provided flexibility for the integration of multi-input for the neural oscillator network that enabled versatile reactive behaviors to be realized for the snake robot.