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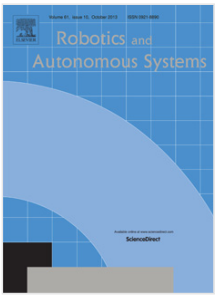

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Central Pattern Generator Based Reflexive Control of Quadruped Walking Robots Using a Recurrent Neural Network

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Abstract

This paper presents a novel Central Pattern Generator (CPG) model for controlling quadruped walking robots. The improvement of this model focuses on generating any desired waveforms along with accurate online modulation. In detail, a well-analyzed Recurrent Neural Network is used as the oscillators to generate simple harmonic periodic signals that exhibit limit cycle effects. Then, an approximate Fourier series is employed to transform those mentioned simple signals into arbitrary desired outputs under the phase constraints of several primary quadruped gaits. With comprehensive closed-form equations, the model also allows the user to modulate the waveform, the frequency and the phase constraint of the outputs online by directly setting inner parameters without the need for any manually tuning. In addition, an associated controller is designed using leg coordination Cartesian position as the control state space based on which stiffness control is performed at sub-controller level. In addition, several reflex modules are embedded to transform the feedback of all sensors into the CPG space. This helps the CPG recognize external disturbances and utilize inner limit cycle effect to stabilize the robot motion. Finally, experiments with a real quadruped robot named AiDIN III performing several dynamic trotting tasks on several unknown natural terrains are presented to validate the effectiveness of the proposed CPG model and controller.

Keywords: Central Pattern Generator, Quadruped Robots, Biomimetic Control.