Submission: 70012

Mechanical Evolution of Flexible-Legged With Reinforcement Learning

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Dynamics, Vibration, and Control Topics

Topic 7-19: Machine Learning and Artificial Intelligence in Dynamics and Vibrations

Machine Learning and Artificial Intelligence are both emerging as invaluable tools for studying a wide variety of research problems. In the area of dynamical systems, these tools are being applied to problems in traffic dynamics, neural dynamics, fluid dynamics, molecular dynamics, multi-agent system dynamics, weather forecasting, and many others. This symposium seeks papers addressing applications of, and theoretical developments in, Machine Learning, Artificial Intelligence, and Deep Learning as applied to the fields of dynamical systems, vibrations, and control. Topics in which these tools are used could include the prediction of dynamical states in complex systems, system identification for linear and nonlinear systems, control of complex systems, and others.

Select a Paper Type

Technical Paper Publication

Insert the Title

Mechanical Evolution of Flexible-Legged With Reinforcement Learning

Provide an Abstract

Legged systems have many advantages when compared to their wheeled counterparts. For example, theycan more easily navigate extreme, uneven terrain. However, there are disadvantages as well, includingdramatically lower energy efficiency. In an effort to mitigate this disadvantage, research has been conductedthat shows using flexible components in operating legged locomotive systems not only increases their efficiencybut also their performance [1].

However, flexible legged locomotive systems are highly nonlinear and are therefore difficult to develop con-trollers for using traditional methods. Trading flexible links for flexible joints is a mechanical solution whichhas been studied to solve some of these difficulties [2]. However, even though these types of systems areeasier to model, they do not represent the full capability of truly flexible systems.

Because of the difficulties encountered in modeling flexible systems, control methods have been proposedthat use neural networks to represent the nonlinear model of the systems and/or implement the controlstrategy itself. One of these methods is reinforcement learning. Beyond tasking a reinforcement learningalgorithm with properly controlling the system, it can also be tasked with learning mechanical parameterssuch as the size and flexibility of links. Previous work has shown that such a method can be successful atdefining both mechanical parameters and control strategies [3], [4].

In this work, rather than training for both mechanical design and control strategies, a reinforcement learningalgorithm is tasked with training an agent to find only the mechanical parameters for a system that hasa predetermined control input. To demonstrate the proposed method, a pogo-stick is used to represent aflexible single-legged system. The agent optimizes the spring constant for the given control input [5] withthe objective of jumping as high as possible. The results presented show that the proposed approach is a promising method of defining mechanical parameters for flexible locomotive systems. The reinforcementlearning algorithm requires little time to train and results in nearly an order of magnitude increase in jumpheight compared to a random agent.

Keywords: Reinforcement Learning, Actor-Critic, Neural Network, Flexible Systems

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I am a mechanical engineering graduate research assistant at the University of Louisiana at Lafayette working on obtaining my Masters in mechanical engineering. I have a passion for all things engineering which is why I have chosen robotics as a field of study. I am working at ULL on broadening my understanding in the fields of AI, (Reinforcement Learning) towards the application of developing control strategies and mechanical designs for flexible legged locomotive systems. I plan to graduate in 2022 and begin my career, continuing work in the field of intelligent robotics. My passion is to be a part of a team working on the kinds of projects which will shape the future as we know it.

Presenting author headshot

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