Temple University Mathematics Colloquium

Philip Holmes

Princeton University

will speak on

The Neuromechanics of Insect Locomotion: How Cockroaches Run Fast and Stably Without Much Thought

ABSTRACT: I will describe several models for running insects, from an energy-conserving biped with passively-sprung legs to a muscle-actuated hexapod driven by a neural central pattern generator (CPG). Phase reduction and averaging theory collapses some 300 differential equations that describe this neuromechanical model to 24 one-dimensional oscillators that track motoneuron phases. The reduced model accurately captures the dynamics of unperturbed gaits and the effects of impulsive perturbations, and phase response and coupling functions provide improved understanding of reflexive feedback mechanisms. Specifically, piecewise-holonomic constraints due to intermittent foot contacts confers asymptotic stability on the CPG-driven feedforward system, and leg force sensors modulate firing patterns to mitigate large perturbations. More generally, I will argue that both simple models and large simulations are necessary to understand such complex systems.

The talk will draw on joint work with Einat Fuchs, Robert Full, Raffaele Ghigliazza, Raghu Kukillaya, Josh Proctor, John Schmitt, Justin Seipel and Manoj Srinivasan.

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Monday, 10 October 2011
Lecture at 4:00 pm
Coffee, tea, and refreshments from 3:30-5:00 pm
Room 617, Wachman Building
Department of Mathematics