

Tutorial: Modeling and Analysis of Dynamic Walking

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Learn the techniques behind dynamic walking, an approach to human and robot locomotion in which the passive dynamics of the limbs can produce natural-looking gaits with little or no control. These techniques have been used to demonstrate both passive dynamic walking machines and actively powered robots, and to study the mechanics, energetics, and control of human walking. This is an intensive, full-day tutorial involving hands-on exercises, to develop the experience and knowledge necessary to apply the dynamic walking approach. Also offered is a shorter, one-hour tutorial summarizing only the principles of dynamic walking, without providing hands-on experience.

Goals: Provide participants with an understanding of the principles of dynamic walking and the skills to perform simulation and analysis of their own models.

Format: The tutorials will be intensive and immersive, with a combination of classroom lectures and hands-on exercises, to ensure that principles are immediately applied and reinforced. Participants will perform exercises in class, with extensive tutoring provided.

Requirements: For hands-on exercises, **participants should bring a laptop computer**, or work with a partner with a computer. **All computers should have Matlab installed** (student versions are acceptable, and free trial versions are available). Also, **you are responsible for purchasing the \$7.50 wifi / internet access** at the time you pre-register for NACOB 2008. After this tutorial, you can use this access for the rest of NACOB 2008 meeting to search the online abstracts, etc.

Schedule: The full-day tutorial will take place as follows.

8:45 am – 12 noon Simulation of a walking step

Topics include integrating equations of motion over one step, detecting discrete events, and applying step-to-step transitions. Learn a simple technique to derive equations of motion and to calculate effect of impulsive events. Build a library of helper functions. Goal: Perform simulations of a complete walking step.

12 – 1 pm Lunch

1 pm – 3:30 pm Limit cycles and analysis of dynamic walking

Topics include methods of nonlinear dynamics such as limit cycles, fixed points, and stability analysis, as well as simple methods for extending complexity of models. Learn how to perform a parameter study and to calculate energetic costs for a walking model. Goal: Find and analyze limit cycles for a walking model.

3:30 pm – 4:30 pm Principles of Dynamic Walking

Learn basic concepts that apply to all dynamic walking models, applications to human experimentation, and methods for quantifying human locomotion from a dynamic walking perspective. Includes a summary of open questions in locomotion research that may be addressed with dynamic walking models. Goal: Understand how and why dynamic walking works, and how it is relevant to human walking.

Prerequisites: Tutorials will be designed to be as accessible as possible. Participants of all backgrounds are invited to attend, but should plan on spending approximately 50% of the time on hands-on exercises that may require some mathematical background.

For maximum benefit, participants should have basic undergraduate experience with dynamics and elementary linear algebra. They should be comfortable performing simple programming in Matlab.

Participants with less technical inclination will be invited to participate in exercises in groups, with a technical consultant to assist in programming and other matters.

Location: 1690 CSE Building, University of Michigan North Campus

Sign up for either:

8:30 am – 4:30 pm Full Day (intensive hands-on tutorial, cost \$40 at the time you pre-register for NACOB 2008)

3:30 – 4:30 pm Principles (abbreviated, lecture-based tutorial, no charge, but seating may be limited. A wait list will be organized if necessary.)