

Jim Schmiedeler

Associate Professor
Aerospace and Mechanical Engineering
University of Notre Dame
Notre Dame, IN



schmiedeler.4@nd.edu

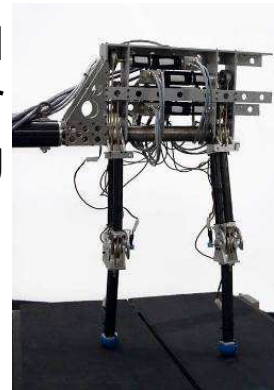
www.nd.edu/~jschmie1/

Research Interests

- Legged robot locomotion
- Human motor coordination
- Robot-assisted rehabilitation
- Human injury biomechanics
- Design of shape-changing mechanisms

Research Highlights

Integrated mechanical and control design for dynamic biped walking



Design of series-elastic actuators for dynamic maneuvers



Time invariant characteristics inform rehab

Honors

- NSF PECASE 2007
- ASME M&R Conference Best Paper Award 2006
- ASME Freudenstein Young Investigator Award 2004

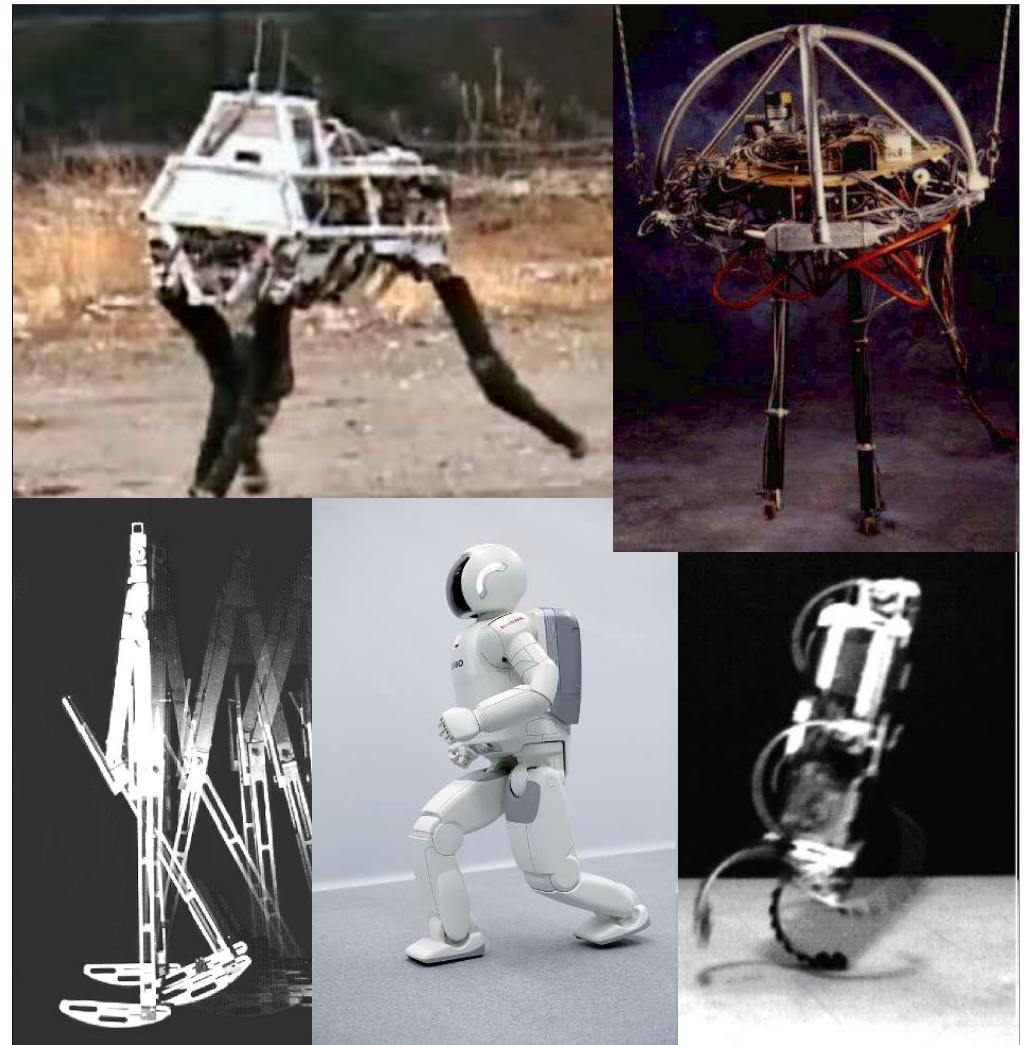
Professional Activities

- ASME Mechanisms & Robotics Committee Member
- ASME Journal of Mechanical Design Associate Editor

Dynamic Maneuvers in Biped Robots

Jim Schmiedeler, University of Notre Dame, schmiedeler.4@nd.edu

- BigDog has captured the imagination of the general public with its ability to execute dynamic maneuvers.
- Most biped robots to date cannot demonstrate the same level of agility.
- Separate approaches that focus on reproducing 1) large numbers of degrees of freedom and 2) the dynamics of very particular maneuvers have not been brought together.
- New technologies AND new control approaches are needed to develop fully dynamic biped robots.



Boston Dynamics' BigDog, Raibert's 3D biped, McGeer's passive walker, Honda's ASIMO, and Buehler's RHex.

Societal Implications

- In-home assistance for the disabled and/or elderly.
- Enhanced battlefield safety for military personnel, particularly in urban combat environments.
- Expanded human-robot interaction in manufacturing facilities.

Accomplishments to Date

- Passive dynamic walking machines exhibit extreme energy efficiency with Poincaré stability analysis.
- Humanoid robots exhibit better robustness with full actuation and Zero Moment Point (ZMP) control.
- Hybrid Zero Dynamics methods and heuristics- or simulation-based stability analysis offer alternatives.

Challenges

- A general metric for 3D dynamic stability that enables mechanical and control design.
- Mechanical systems and control strategies that provide for energy-efficient dynamic locomotion.
- Efficient actuation systems with high power density and inherent compliance.

5/10/20 Year Vision

- FIVE years – New understanding of 3D dynamic stability.
- TEN years – New actuators that approach human muscle power density with variable compliance.
- TWENTY years – Integrated biped systems with the robustness and efficiency to function in a commercial/industrial/military setting.