

# CURRICULUM VITAE

## Hartmut Geyer

The Robotics Institute  
Carnegie Mellon University  
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### RESEARCH INTERESTS

Principles of legged dynamics and control, their relation to human motor control, and resulting applications in humanoid and rehabilitation robotics.

### EDUCATION

- 2005 Ph.D. in Social and Behavioral Sciences (Biomechanics)  
Friedrich-Schiller-University Jena  
Thesis Title: Simple models of legged locomotion based on compliant limb behavior  
Advisor: Reinhard Blickhan
- 2001 Diploma in Physics  
Friedrich-Schiller-University Jena, Germany

### PROFESSIONAL EXPERIENCE

- 2010-present Assistant Professor, Robotics Institute,  
Carnegie-Mellon University
- 2010-present Assistant Professor by Courtesy, Mechanical Engineering,  
Carnegie-Mellon University
- 2010-present Assistant Professor by Courtesy, Biomedical Engineering,  
Carnegie-Mellon University
- 2009-2010 Postdoctoral Associate, Department of Information Technology and Electrical  
Engineering, Swiss Federal Institute of Technology Zurich
- 2006-2007 Postdoctoral Affiliate, Media Laboratory,  
Massachusetts Institute of Technology
- 2006-2008 Postdoctoral Affiliate, School of Social and Behavioral Sciences,  
Friedrich-Schiller-University Jena

### FELLOWSHIPS AND AWARDS

- 2006-2008 EU Marie-Curie Outgoing International Fellowship
- 2003 International Society of Biomechanics Conference Travel Grant
- 2001-2003 German Academic Exchange Service Graduate Student Fellowship

## PUBLICATION LIST

### Chapters in Books

1. H Geyer, U Saranlı. Gait based on the spring mass model. In *Humanoid Robotics: A Reference*. Eds. P Vadakkepat, A Goswami, and J Kim. Springer. In review (invited).
2. H Geyer, A Seyfarth. Neuromuscular Model Control for Humanoid Walking. In *Humanoid Robotics: A Reference*. Eds. P Vadakkepat, A Goswami, and J Kim. Springer. In preparation (invited).
3. A Seyfarth, H Geyer, R Blickhan, S Lipfert, J Rummel, Y Minekawa, F Iida. Running and walking with compliant legs. In *Fast Motions in Biomechanics and Robotics: Optimization and Feedback*. Lecture Notes in Control and Information Science (eds. M Diehl, K Mombauer), 383-402, Springer, Heidelberg, 2006.

### Refereed Journal Papers

4. N Thatte, H Geyer. Towards local reflexive control of a powered transfemoral prosthesis for robust amputee push and trip recovery. *IEEE Transactions on Biomedical Engineering, Special Section on Modeling and Design in Neurorehabilitation and Augmentation Technologies*. Eds. M Sartori and D. Farina. In review (invited).
5. S Song, H Geyer. A neural circuitry that emphasizes spinal feedbacks generates diverse behaviors of human locomotion. *Journal of Physiology*, doi: 10.1113/JP270228, accepted.
6. A Wu, H Geyer. The 3D Spring-Mass Model Reveals a Time-based Deadbeat Control for Highly Robust Running and Steering in Uncertain Environments. *IEEE Transactions on Robotics*. 29(5): 1114-1124, 2013.
7. M Ernst, H Geyer, R Blickhan. Extension and customization of self-stability control in compliant legged systems. *Bioinspiration and Biomimetics* 7 doi:10.1088/1748-3182/7/4/046002, 2012.
8. H Geyer, HM Herr. A muscle-reflex model that encodes principles of legged mechanics produces human walking dynamics and muscle activities. *IEEE Transactions on Neural Systems and Rehabilitation Engineering* 18: 263–273, 2010.
9. M Eilenberg, H Geyer, HM Herr. Control of a powered ankle-foot prosthesis based on a neuromuscular model. *IEEE Transactions on Neural Systems and Rehabilitation Engineering* 18:164-173, 2010.
10. R Blickhan, A Seyfarth, H Geyer, S Grimmer, H Wagner. Intelligence by mechanics. *Philosophical Transactions of the Royal Society A* 365: 199-220, 2007.
11. H Geyer, A Seyfarth, R Blickhan. Compliant leg behaviour explains basic dynamics of walking and running. *Proceedings of the Royal Society B* 273: 2861-2867, 2006.
12. H Knuesel, H Geyer, A Seyfarth. Influence of swing leg movement on running stability. *Human Movement Science* 24: 532-543, 2005.
13. H Geyer, A Seyfarth, R Blickhan. Spring-mass running: simple approximate solution and application to gait stability. *Journal of Theoretical Biology* 232: 315-328, 2005.
14. H Geyer, A Seyfarth, R Blickhan. Positive force feedback in bouncing gaits? *Proceedings of the Royal Society B* 270: 2173-2183, 2003.
15. A Seyfarth, H Geyer, HM Herr. Swing-leg retraction: a simple control model for stable running. *Journal of Experimental Biology* 205: 2547-2555, 2003.
16. A Seyfarth, H Geyer, M Guenther, R Blickhan. A movement criterion for running. *Journal of*

### **Refereed Conference/Workshop Papers**

17. W Martin, A Wu, H Geyer. Robust Spring Mass Model Running for a Physical Bipedal Robot. *IEEE International Conference on Robotics and Automation*, Seattle, WA, accepted.
18. H Vejdani, A Wu, H Geyer, J Hurst. Touch-down angle control for spring-mass walking. *IEEE International Conference on Robotics and Automation*, Seattle, WA, accepted.
19. R Desai, H Geyer, J Hodgins. Virtual Model Control for Dynamic Lateral Balance. *IEEE-RAS International Conference on Humanoid Robots, Madrid, Spain*, pp. 856-861, 2014.
20. N Thatte, H Geyer. Towards local reflexive control of a powered transfemoral prosthesis for robust amputee push and trip recovery. *IEEE/RSJ International Conference on Intelligent Robots and Systems*, Chicago, IL, pp. 2069 - 2074, 2014.
21. A Wu, H Geyer. Highly robust running of articulated bipeds in unobserved terrain. *IEEE/RSJ International Conference on Intelligent Robots and Systems*, Chicago, IL, pp. 2558 - 2565, 2014.
22. A Schepelmann, K Geberth, H Geyer. Compact nonlinear springs with user defined torque-deflection profiles for series elastic actuators. *IEEE International Conference on Robotics and Automation*, Hong Kong, China, pp. 3411 - 3416, 2014.
23. S Song, H Geyer. Generalization of a Muscle-Reflex Control Model to 3D Walking. *IEEE Annual International Conference of the Engineering in Medicine and Biology Society, Osaka, Japan*, pp. 7463-7466, 2013.
24. S Song, R Desai, H Geyer. Integration of an adaptive swing control into a neuromuscular human walking model. *IEEE Annual International Conference of the Engineering in Medicine and Biology Society, Osaka, Japan*, pp. 4915-4918, 2013.
25. S Song, C LaMontagna, SH Collins, H Geyer. The effect of foot compliance encoded in the windlass mechanism on the energetics of human walking. *IEEE Annual International Conference of the Engineering in Medicine and Biology Society, Osaka, Japan*, pp. 3179-3182, 2013.
26. R Desai, H Geyer. Muscle-Reflex Control of Robust Swing Leg Placement. *IEEE International Conference on Robotics and Automation, Karlsruhe, Germany*, pp. 2169-2174, 2013.
27. R Desai, H Geyer. Robust swing leg placement under large disturbances. *IEEE International Conference on Robotics and Biomimetics, Guangzhou, China*, pp. 265-270, 2012.
28. DFB Haeufle, MD Taylor, S Schmitt, H Geyer. A clutched parallel elastic actuator concept: Towards energy efficient powered legs in prosthetics and robotics. *Proceedings of the IEEE International Conference on Biomedical Robotics and Biomechatronics*, Rome, Italy, pp. 1614-1619, 2012.
29. A Schepelmann, MD Taylor, H Geyer. Development of a testbed for robotic neuromuscular controllers. *Proceedings of Robotics: Science and Systems VIII*, Sydney, Australia, pp. 385-392, 2012.
30. S Song, H Geyer. Regulating Speed and Generating Large Speed Transitions in a Neuromuscular Human Walking Model. *Proceedings of the IEEE International Conference on Robotics and Automation*, St. Paul, Minnesota, pp. 511-516, 2012.
31. S Song, H Geyer. The Energetic Cost of Adaptive Feet in Walking. *Proceedings of the IEEE International Conference on Robotics and Biomimetics*, Phuket, Thailand, pp. 1597-1602, 2011.
32. F Parietti, H Geyer. Reactive balance control in walking based on a bipedal linear inverted pendulum

model. *Proceedings of the Proceedings of the IEEE International Conference on Robotics and Automation*, Shanghai, China, pp. 5442-5447, 2011.

33. M Ernst, H Geyer, R Blickhan. Spring-legged locomotion on uneven ground: a control approach to keep the running speed constant, *Proceedings of the 12th International Conference on Climbing and Walking Robots (CLAWAR)* pp. 639-644 (eds. O Tosun, HL Akin, MO Tokhi, GS Virk), ISBN 981-4291-26-9, Istanbul, Turkey, 2009.
34. A Seyfarth, KT Kalveram, H Geyer. Simulating muscle-reflex dynamics in a simple hopping robot. *Autonome Mobile Systeme 2007* (eds. K Berns and T Luksch), Springer: 294-300, 2007.
35. H Geyer, A Seyfarth, R Blickhan. Compliant limb behavior: Exploiting the basic mechanics of biological legged locomotion for the control of legged systems. *Proceedings of the 8th International Conference on Motion and Vibration Control (MOVIC)*, Daejeon, Korea, 2006.
36. E Dittrich, H Geyer, A Karguth, A Seyfarth. Obstacle avoidance in a simple hopping robot. *Proceedings of the 9th International Conference on Climbing and Walking Robots (CLAWAR)*, Brussels, Belgium, 2006.
37. H Geyer, A Seyfarth, R Blickhan. Should humanoids really walk on rigid legs? *Proceedings of the 3rd International Symposium on Adaptive Motion in Animals and Machines (AMAM)*, Ilmenau, Germany, ISBN: 3938843039, 2005.
38. H Geyer, A Seyfarth, Blickhan, R. Natural dynamics of spring-like running: Emergence of self-stability. In *Proceedings of the 5th International Conference on Climbing and Walking Robots (CLAWAR)* (eds. P Bidaud and FB Amar), Professional Engineering Publishing Ltd., London. pp. 87-91, 2002.
39. A Seyfarth, H Geyer. Natural control of spring-like running: Optimized self-stabilization. In *Proceedings of the 5th International Conference on Climbing and Walking Robots (CLAWAR)* (eds. P Bidaud and FB Amar), Professional Engineering Publishing Ltd., London. pp. 81-85, 2002.

### **Patents and Invention Disclosures**

40. R Desai, H Geyer. Robust swing leg controller under large disturbances. US Patent pending. (application number 14/470,277), 2014.
41. HM Herr, H Geyer, MF Eilenberg. Model-based neuromechanical controller for a robotic leg. US Patent US patent No. 8864846, 2010.
42. HM Herr, A Seyfarth, H Geyer. Speed-adaptive control scheme for legged running robots. US Patent 7295892, 2003.

### **INVITED TALKS**

#### **Conferences and Workshops**

- Decentralized control approaches to behavior adaptation in legged robots and powered prostheses based on neuromuscular models of human locomotion. *7th Intl. Symposium on Adaptive Motion of Animals and Machines*, Cambridge, MA, June 2015.
- The functional role of CPGs in legged systems that require active balancing remains an open and compelling research problem. *ICRA 2015 Workshop: CPGs for Locomotion Control: Pros, Cons, and*

*Alternatives*, Seattle, WA, May 2015.

- Decentralized control in natural and artificial legged systems. *Dynamic Locomotion Workshop, Robotics: Science and Systems Conference*, Berkeley, CA, July 2014.
- Decentralized control in natural and artificial legged systems. *Dynamic Walking Symposium, World Congress of Biomechanics*, Boston, MA, July 2014.
- Decentralized swing leg control in human gait and prosthetics application. *17th U.S. National Congress on Theoretical and Applied Mechanics*, Michigan State University, East Lansing, MI, June 2014.
- Legged dynamics and control: Basic models, neuromuscular interpretation, and robotic application. *Semi-plenary Presentation, European Control Conference, Zurich, Switzerland*, July 2013.
- Neuromuscular model of human locomotion based on spinal reflexes that embed fundamental principles of legged dynamic systems. *11th Intl Symposium on Computer Methods in Biomechanics and Biomedical Engineering*, Salt Lake City, UT, April 2013.
- A few neurons may be enough to operate high-mobility prosthetic legs, *Bioimage & Biosignal Processing Day, Biomedical Engineering Department, Carnegie Mellon University*, Pittsburgh, PA, February 2012.
- Neuromechanical Models for Humanoids and Rehabilitation Robots, *Workshop on motor control principles in neuro-robotics and rehabilitation, IEEE Conference on Engineering in Medicine and Biology*, Boston, MA, August 2011.
- What breakthroughs does the field of legged dynamics need?, *Dynamic Walking Conference*, Jena, Germany, July 2011.
- Reflex-based control of walking assistance, *International Conference on Rehabilitation Robotics, Workshop on physiological principles of locomotion required for robot design*, Zurich, Switzerland, July 2011.
- A model of biped walking based on muscle reflexes that encode principles of legged mechanics, *IEEE Humanoids 2009 Conference Workshop on Modeling, Simulation and Optimization of Bipedal Walking*, Paris, December 2009.
- Principles of legged dynamic systems and their impact on human motor control and rehabilitation technology, *School of Computer Science Seminar, Carnegie Mellon University*, Pittsburgh, PA, April 2009.
- Gang als Wechselspiel von passiver Mechanik und dezentraler Kontrolle: Modellierung und Anwendung in der Rehabilitation', *Annual Meeting of the German Society of Clinical Neurophysiology*, Munich, Germany, March 2009.
- Adaptive walking models and prostheses, *Workshop on Adaptive Motion in Man, Animals and Machines*, Jena, Germany, February 2009.
- An integrative view on legged locomotion obtained from the bipedal spring-mass dynamics, *Dynamic Walking Workshop*, Ann Arbor, MI, May 2006.

### **Seminars and Colloquia at Universities and Industry**

- Decentralized control in natural and artificial legged systems. *Applied Mechanics Seminar Series, School of Engineering and Applied Sciences, Harvard University*, MA, January 2014.

- Legged dynamic systems. *Parker Hannifin, Irwin, PA*, June 2013.
- Legged mobility: Basic models, neuromuscular interpretation, and application in rehabilitation robotics. *Bioengineering Seminar Series, Swanson School of Engineering, University of Pittsburgh, PA*, December 2012.
- State of the art in gait modeling, Workshop on Gait Modeling - Visions for the Lokomat Therapy, *Hocoma AG, Zurich*, October 2009.
- From legged dynamics to motor control of human locomotion, *Engineering, Neuroscience, and Health Seminar Series, Biomedical Engineering Department, University of Southern California, CA*, September 2008.
- Human locomotion: From basic mechanics to motor control to biomedical applications, *Sensory Motor Performance Program Seminars, Rehabilitation Institute of Chicago*, April 2008.
- Body intelligence: How passive mechanics shape the motor control of human locomotion, *Brown Bag Seminars, Artificial Intelligence Laboratory, University of Zurich, Switzerland*, February 2008.
- Control Principles of Human Locomotion, *Neuro-Colloquium, Neurocenter, University of Freiburg, Germany*, June 2007.
- From simple to complex models of locomotion that embrace and exploit compliant leg behavior, *Boston Dynamics, Robotics Division, Cambridge, MA*, September 2006.
- Gaining insights into legged locomotion by hierarchically exploiting compliant leg behavior, *Dynamical Systems and Nonlinear Science Seminar, Princeton University, Princeton, NJ*, April 2006.
- Gaining control over legged locomotion by using compliant legs, *Department of Adaptive Machine Systems, Osaka University, Osaka, Japan*, November 2005.

## Other

- Invited Lecturer, *Robotics Summer Schools at ETH Zurich, Switzerland*, 11-15 July, 2011.

## TEACHING EXPERIENCE

### Courses taught at Carnegie Mellon

Spring 2015	16-711: Kinematics, Dynamic Systems, and Control (graduate level, 12 units, 46 students)
Fall 2014	16-868: Biomechanics and Motor Control (graduate level, 12 units, 25 students), 16-642: Manipulation, Mobility and Control (graduate level, 12 units, 44 students)
Spring 2014	16-711: Kinematics, Dynamic Systems, and Control (graduate level, 12 units, 47 students),
Fall 2013	16-868: Biomechanics and Motor Control (graduate level, 12 units, 21 students) 16-642: Manipulation, Mobility and Control (graduate level, 12 units, 38 students)
Spring 2013	16-711: Kinematics, Dynamic Systems, and Control (graduate level, 12 units, 46 students),
Fall 2012	16-868: Biomechanics and Motor Control (graduate level, 12 units, 13 students) 16-642: Manipulation, Mobility and Control (graduate level, 12 units, 36 students),
Spring 2012	16-711: Kinematics, Dynamic Systems, and Control (graduate level, 12 units, 44 students), <i>course curriculum redesigned</i>

- Fall 2011      16-899B: Biomechanics and Motor Control (graduate level, 12 units, 8 students)  
 16-642: Manipulation, Mobility and Control (graduate level, 12 units, 19 students),  
 first time offering, *course curriculum co-designed with G. Kantor and D. Apostolopoulos for  
 new Master of Science - Robotic Systems Development Program of Robotics Institute*
- Spring 2011    16-711: Kinematics, Dynamic Systems, and Control (graduate level, 12 units, ~35 students)
- Fall 2010      16-899B: Biomechanics and Motor Control (graduate level, 12 units, ~23 students),  
 first time offering, *course curriculum designed*

### **Courses taught outside Carnegie Mellon**

- Fall 2009      227-0231-00: Introduction to Dynamics and Control of Legged Locomotion (graduate  
 level, ~20 students), ETH Zurich, Switzerland.

## **EXTERNAL PROFESSIONAL ACTIVITIES**

### **Conferences and Workshop Committees**

- Finance chair, IEEE Workshop on Advanced Robotics and its Social Impact, Evanston, IL, 11-13 September, 2014.
- Co-organizer, Dynamic Walking Conference, Pittsburgh, PA, 10-13 June, 2013.
- Program committee member, Robotics: Science and Systems Conference, 2012, 2011.
- Track co-chair, Track: Prosthetic Biomechanics and Robotics: Artificial Organs/Limbs, 33rd Annual International Conference of the IEEE Engineering in Medicine and Biology Society, 2011.
- Co-organizer, International Workshop on Legged Locomotion, Cambridge, MA, 27-28 April, 2007.

### **Membership in Professional Societies**

- Current: IEEE
- Past: International Society of Biomechanics, Society of Experimental Biology, German Physical Society

### **Article Reviews**

- Ad-hoc Journal Reviewer: Autonomous Robots, International Journal of Robotics Research, Robotics and Autonomous Systems, IEEE Transactions on Robotics, International Journal of Humanoid Robotics, IEEE Transactions on Biomedical Engineering, Mechanisms and Machine Theory, Journal of Dynamic Systems, Measurement, and Control, Prosthetics and Orthotics International, IOP Bioinspiration and Biomimetics, Journal of Physiology A, Journal of Applied Physiology, Journal of Experimental Biology, Proceedings of the Royal Society A and B, Journal of Theoretical Biology, Journal of the Royal Society Interface, Proceedings of the National Academy of Science (2006-2015).
- Recent Ad-hoc Conference/Workshop Reviewer: IEEE International Conference on Robotics and Automation (ICRA), International Conference on Intelligent Robots and Systems (IROS), Robotics: Science and Systems Conference (RSS), IEEE RAS International Conference on Humanoid Robots (Humanoids), IEEE RAS/EMBS International Conference on Biomedical Robotics and Biomechatronics

(BioRob), (2012-2015).

### **Panel Reviews**

- NSF, 2013-2015
- NIDRR, 2010