

Hartmut Geyer

Robotics Institute
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Research Interests

Principles of legged dynamic systems, the relation of these principles to the neuromuscular control of human locomotion, and resulting applications in rehabilitation engineering.

Education

- Jun 05 Ph. D. in Social and Behavioral Sciences (Biomechanics)
Friedrich-Schiller-University of Jena, Jena, Germany
Thesis Title: *Simple models of legged locomotion based on compliant limb behavior*
Advisor: Reinhard Blickhan
- Apr 01 Diploma in Physics
Friedrich-Schiller-University of Jena, Jena, Germany

Fellowships and Awards

- Jan 06 – Dec 08 EU Marie-Curie Outgoing International Fellowship
- Jul 03 ISB Conference Travel Grant
- Aug 01 – Jul 03 DAAD Graduate Student Scholarship

Research Experience

- Feb 10 – present **Carnegie Mellon University**, Pittsburgh, PA
Assistant Professor, Robotics Institute
- Jan 09 – Dec 09 **Swiss Federal Institute of Technology (ETH)**, Zurich, Switzerland
Postdoctoral Associate, Automatic Control Laboratory (Prof. M. Morari)
- Mar 08 – Dec 08 **Friedrich-Schiller-University of Jena**, Jena, Germany
Postdoctoral Affiliate, Locomotion Laboratory (Dr. A. Seyfarth)
- Sep 07 – Feb 08 **Swiss Federal Institute of Technology**, Zurich, Switzerland
Postdoctoral Affiliate, Automatic Control Laboratory (Prof. M. Morari)
- Feb 06 – Aug 07 **Massachusetts Institute of Technology**, Cambridge, MA
Postdoctoral Affiliate, Biomechatronics Group (Prof. H. Herr)

- Jan 06 – Dec 08 **Friedrich-Schiller-University of Jena**, Jena, Germany
EU Marie-Curie Fellow
- Oct 03 – Jan 06 **Friedrich-Schiller-University of Jena**, Jena, Germany
Research Assistant, Locomotion Laboratory (Dr. A. Seyfarth)
- Aug 02 – Sep 03 **University of Zurich**, Zurich, Switzerland
Visiting Student, Balgrist Spinal Cord Injury Center (Prof. V. Dietz)
- Aug 01 – Jul 02 **Massachusetts Institute of Technology**, Cambridge, MA
Visiting Student, Leg Laboratory (Prof. H. Herr)
- Aug 01 – Jul 03 **Friedrich-Schiller-University Jena**, Jena, Germany
DAAD Scholar

Teaching Experience

Swiss Federal Institute of Technology, Zurich, Switzerland
Department of Information Technology and Electrical Engineering

- Sep 09 – Dec 09 **Lecturer**, Introduction to Dynamics and Control of Legged Locomotion.

Friedrich-Schiller-University of Jena, Jena, Germany
School of Social and Behavioral Sciences

- Oct 04 – Feb 05 **Instructor**, Statistics Seminar for Master Students in Sport Science.
- Oct 04 – Feb 05 **Instructor**, Graduate Student Seminar on Digital Signal Processing.
- Apr 04 – Aug 04 **Instructor**, Graduate Student Seminar on Integrative Analysis of Human Motion.
- Oct 03 – Feb 04 **Teaching Assistant**, Integrative Analysis of Human Motion for Master Students in Sport Science.

Refereed Journal Articles

1. H Geyer, HM Herr. A muscle-reflex model that encodes principles of legged mechanics produces human walking dynamics and muscle activities. *IEEE Trans Neural Syst Rehabil Eng.* In Press.
2. M Eilenberg, H Geyer, HM Herr. Control of a powered ankle-foot prosthesis based on a neuromuscular model. *IEEE Trans Neural Syst Rehabil Eng.* In Press.
3. R Blickhan, A Seyfarth, H Geyer, S Grimmer, H Wagner. Intelligence by mechanics. *Phil Trans R Soc A* **365**: 199–220, 2007.
4. H Geyer, A Seyfarth, R Blickhan. Compliant leg behaviour explains basic dynamics of walking and running. *Proc R Soc B* **273**: 2861–2867, 2006.
5. H Knuesel, H Geyer, A Seyfarth. Influence of swing leg movement on running stability. *Hum Mov Sci* **24**: 532–543, 2005.

6. H Geyer, A Seyfarth, R Blickhan. Spring-mass running: simple approximate solution and application to gait stability. *J Theor Biol* **232**: 315–328, 2005.
7. H Geyer, A Seyfarth, R Blickhan. Positive force feedback in bouncing gaits? *Proc R Soc B* **270**: 2173–2183, 2003.
8. A Seyfarth, H Geyer, HM Herr. Swing-leg retraction: a simple control model for stable running. *J Exp Biol* **205**: 2547–2555, 2003.
9. A Seyfarth, H Geyer, M Guenther, R Blickhan. A movement criterion for running. *J of Biomech* **35**: 649–655, 2002.

Manuscripts in Submission or Preparation

1. H Geyer. An approximate solution to human locomotion at the level of the center of mass. *J Theor Biol*. In revision.

Refereed Conference Articles

1. M Ernst, H Geyer, R Blickhan. Spring-legged locomotion on uneven ground: a control approach to keep the running speed constant, *Proc 12th Int Conf 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.
2. 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.
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.
4. H Geyer, A Seyfarth, R Blickhan. Compliant limb behavior: exploiting the basic mechanics of biological legged locomotion for the control of legged systems. *Proc 8th Int Conf on Motion and Vibration Control (MOVIC)*, Daejeon, Korea, 2006.
5. E Dittrich, H Geyer, A Karguth, A Seyfarth. Obstacle avoidance in a simple hopping robot. *Proc 9th Int Conf on Climbing and Walking Robots (CLAWAR)*, Brussels, Belgium, 2006.
6. H Geyer, A Seyfarth, R Blickhan. Should humanoids really walk on rigid legs? *Proc 3rd Int Symposium on Adaptive Motion in Animals and Machines (AMAM)*, Ilmenau, Germany, ISBN: 3938843039, 2005.
7. H Geyer, A Seyfarth, Blickhan, R. Natural dynamics of spring-like running: emergence of self-stability. In *5th Int Conf on Climbing and Walking Robots (CLAWAR)*, eds. P Bidaud and FB Amar, Professional Engineering Publishing Ltd., London. pp. 87–91, 2002.
8. A Seyfarth, H Geyer. Natural control of spring-like running: optimized self-stabilization. In *5th Int Conf on Climbing and Walking Robots (CLAWAR)*, eds. P Bidaud and FB Amar, Professional Engineering Publishing Ltd., London. pp. 81–85, 2002.

Invited Talks

1. '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.
2. 'State of the art in gait modeling', Workshop on Gait Modeling - Visions for the Lokomat Therapy, Hocoma AG, Zurich, October 2009.
3. 'Principles of legged dynamic systems and their impact on human motor control and rehabilitation technology', School of Computer Science Seminar, Carnegie Mellon University, Pennsylvania, April 2009.
4. '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, March 2009.
5. 'Adaptive walking models and prostheses', Workshop on Adaptive Motion in Man, Animals and Machines, Jena, February 2009.
6. 'From legged dynamics to motor control of human locomotion', Engineering, Neuroscience, and Health Seminar Series, Biomedical Engineering Department, University of Southern California, September 2008.
7. 'Human locomotion: from basic mechanics to motor control to biomedical applications', Sensory Motor Performance Program Seminars, Rehabilitation Institute of Chicago, April 2008.
8. 'Body intelligence: how passive mechanics shape the motor control of human locomotion', Brown Bag Seminars, Artificial Intelligence Laboratory, University of Zurich, February 2008.
9. 'Control Principles of Human Locomotion', Neuro-Colloquium, Neurocenter, University of Freiburg, Germany, June 2007.
10. 'From mechanics to motor control of compliant legged locomotion', Concord Field Station Seminar, Harvard University, Cambridge, MA, May 2007.
11. 'From simple to complex models of locomotion that embrace and exploit compliant leg behavior', Boston Dynamics, Robotics Division, Cambridge, MA, September 2006.
12. 'An integrative view on legged locomotion obtained from the bipedal spring-mass dynamics', Dynamic Walking Workshop, Ann Arbor, MI, May 2006.
13. 'Gaining insights into legged locomotion by hierarchically exploiting compliant leg behavior', Dynamical Systems and Nonlinear Science Seminar, Princeton University, Princeton, NJ, April 2006.
14. 'Gaining control over legged locomotion by using compliant legs', Department of Adaptive Machine Systems, Osaka University, Osaka, Japan, November 2005.

Professional Activities

Workshop Organization Co-organizer, "International Workshop on Legged Locomotion", Cambridge, MA, 27-28 April, 2007.

Memberships Society of Experimental Biology, International Society of Biomechanics, German Physical Society (DPG).

Journal Reviews Autonomous Robots, International Journal of Robotics Research, Robotics and Autonomous Systems, IEEE Transaction on Robotics, International Journal of Humanoid Robotics, Mechanisms and Machine Theory, 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, Journal of Theoretical Biology.

Patents

1. HM Herr, EC Martinez-Villalpando, H Geyer, MF Eilenberg, JA Weber. Biomimetic robotic leg with agonist antagonist actuation. US Patent pending, 2009.
2. HM Herr, A Seyfarth, H Geyer. Speed-adaptive control scheme for legged running robots. US Patent 7295892, 2003.