

Kickoff - Proseminar “Gait assistive devices”



Participants

Josefine	Gaßner
Matthias	Lehner
Abdallah	Attawia
Robert	Lang
Jonas	Erasmus
Constantin	Geiger
Marcus	Hott
Eric	Luyken

Topic

Motivation - Why does gait need assistance?

- **Mobility is key!**
 - Moving about our environment is a large part of our life, enabling us to communicate and interact.
- **It becomes possible!**
 - Modern sensors, actuators and microprocessors can be combined to enhance gait training in rehabilitation and restore mobility in medical facilities and communities.
- **It's needed!**
 - An ageing society generates a large demand for restoring and augmenting mobility.
 - Progress in medicine demands technologies to enhance mobility of handicapped people
 - Biomechanical findings and economic pressure demands for automated gait training
 - ...

Questions: What robotic solutions exist which support gait rehabilitation, restoration or enhancement of mobility.

Goal: Develop an understanding of the current state and potential of robotic gait assistance while improving your scientific writing and presentation skills.

Proseminar Tasks

- Get motivated! Develop a passion for gait assisting robots!
- Choose one of the available topics (1 student per topic), discuss with tutor
- Perform literature research (exhaustive!) and write survey paper (quality!)
- Get a review for your paper, submission by early December (Renjewski). Update if necessary until acceptance (~December 2015).
- Design a poster and present it (~January 2015)

Discussion: Experience with gait assistance

- Experiences with the topic?
- Accidents / injuries?
- Cultural perspective?
- Limits of technology?
- New use cases?



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HONDA

Research Topics

1. Challenges and state of the art
2. Market potential and customer demands
3. Gait simulation and simulators
4. Control of stationary gait trainers
5. Control of mobility devices
6. Gaming in gait rehabilitation
7. Orthoses and prostheses
8. Non-legged mobility devices

1. Challenges and state of the art

- Target groups of gait assistance?
 - Martins, Maria M., et al. "Assistive mobility devices focusing on Smart Walkers: Classification and review." *Robotics and Autonomous Systems* 60.4 (2012): 548-562.
- Existing devices in research and on the market.
 - product survey

2. Market potential and customer demands

- Current providers of commercial exoskeletons and their products?
 - Gwynne, Peter. "Technology: Mobility machines." *Nature* 503.7475 (2013): S16-S17.
- What are likely target groups?
 - Guizzo, Erico, and Harry Goldstein. "The rise of the body bots [robotic exoskeletons]." *Spectrum, IEEE* 42.10 (2005): 50-56.

3. Gait simulation and simulators

- What common models of gait simulation exist? What simulators are used?
 - Geyer, H. & Herr, H. A Muscle-Reflex Model That Encodes Principles of Legged Mechanics Produces Human Walking Dynamics and Muscle Activities. *IEEE Trans. Neural Syst. Rehabil. Eng.* **18**, 263273 (2010).
 - Delp, Scott L., et al. "OpenSim: open-source software to create and analyze dynamic simulations of movement." *Biomedical Engineering, IEEE Transactions on* 54.11 (2007): 1940-1950.

What are common challenges in gait simulation with impact on control?

4. Control of stationary gait trainers

- What are stationary gait trainers used for?
 - Jezernik, S, Colombo, G & Keller, T. Robotic orthosis lokomat: A rehabilitation and research tool. *Technology at the ...* (2003).
- Common control strategies in robotic gait trainers
 - Anam, K & Al-Jumaily, AA. Active exoskeleton control systems: State of the art. *Procedia Engineering* (2012).

5. Control of mobility devices

- What special challenges do mobile gait assistants face? What control approaches exist?
 - Mertz, Leslie. "The next generation of exoskeletons: Lighter, cheaper devices are in the works." *Pulse, IEEE* 3.4 (2012): 56-61.
 - Quintero, Hugo A., Ryan J. Farris, and Michael Goldfarb. "A method for the autonomous control of lower limb exoskeletons for persons with paraplegia." *Journal of medical devices* 6.4 (2012): 041003.
 - Contreras-Vidal, Jose L., and Robert G. Grossman. "NeuroRex: A clinical neural interface roadmap for EEG-based brain machine interfaces to a lower body robotic exoskeleton." *Engineering in medicine and biology society (EMBC), 2013*

6. Gaming in gait rehabilitation

- What kind of games can help solving what problems in gait rehabilitation?
 - Zimmerli, Lukas, et al. "Virtual reality and gait rehabilitation Augmented feedback for the Lokomat." *Virtual Rehabilitation International Conference, 2009*. IEEE.
 - Labruyère, Rob, et al. "Requirements for and impact of a serious game for neuro-pediatric robot-assisted gait training." *Research in developmental disabilities* 34.11 (2013): 3906-3915.

7. Orthoses and prostheses

- Modern control approaches for actuated prosthesis control
 - Holgate, Matthew, Alexander W. Böhler, and Thomas G. Sugar. "Control algorithms for ankle robots: A reflection on the state-of-the-art and presentation of two novel algorithms." *Biomedical Robotics and Biomechatronics, 2008. BioRob 2008. 2nd IEEE RAS & EMBS International Conference on*. IEEE, 2008.
 - Eilenberg, Michael F., Hartmut Geyer, and Hugh Herr. "Control of a powered ankle-foot prosthesis based on a neuromuscular model." *Neural Systems and Rehabilitation Engineering, IEEE Transactions on* 18.2 (2010): 164-173.

8. Non-legged mobility devices

- What are key problems of legged robots and what mobility challenges can be solved by non-legged devices?
 - Gwynne, Peter. "Technology: Mobility machines." *Nature* 503.7475 (2013): S16-S17.
- What are current technical challenges in non-legged mobility devices?
 - Levine, Simon P., et al. "The NavChair assistive wheelchair navigation system." *Rehabilitation Engineering, IEEE Transactions on* 7.4 (1999): 443-451.

Paper submission

- Use provided template (LaTeX anybody?)
- Submit by Dec. 13th
- 6-8 pages

Presentation

- January (26.1.2016)?
- 10 min + 10 min discussion
- Minimal content:
 - Detailed problem statement – find a relevant topic that excites you and state it clearly
 - Researched solutions and approaches – identify relevant literature and summarize it
 - Advantages and Disadvantages – state the current state of the art and problems
 - Open Questions – Possible solutions.

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Jonas	Erasmus	
Constantin	Geiger	1
Marcus	Hott	
Eric	Luyken	

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