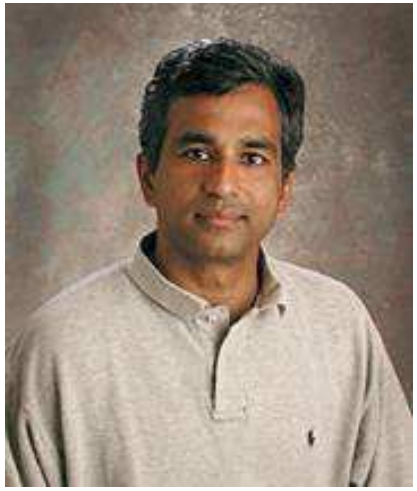

Sunil Agrawal

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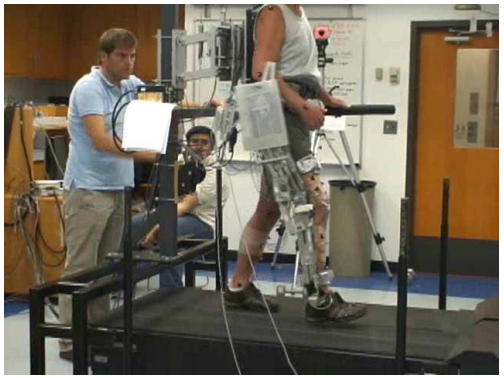
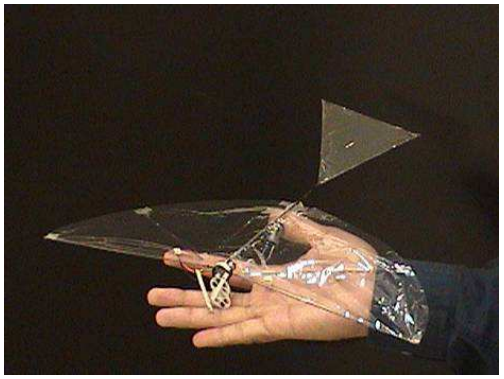
Research Interests: Rehabilitation, Bio-Inspired Robots

- Lower Extremity Exoskeletons
  - Gravity Balancing Designs
  - Motorized Designs
  - Gait training of Stroke Survivors
- Mobility Enhancement of Developmentally Delayed Infants
- Flapping-Wing Bio-Inspired Designs of MAVs
- Differentially Flat Designs of Under-actuated Arms and Mobile Robots

Research Highlights



NIH R01 HD 038582: 2008-2013



NSF CMMI 0625367: 2006-2009
NSF IIS 0705419: 2007-2010

Honors

- NSF Presidential Faculty Fellow, White House 1994
- Freidrich W. Bessel Award, Germany 2001
- Fellow of ASME, 2004
- Humboldt U.S. Senior Scientist Award, 2007
- MSC Software Simulation Award, 31st ASME Mechanisms and Robotics Conference, 2007

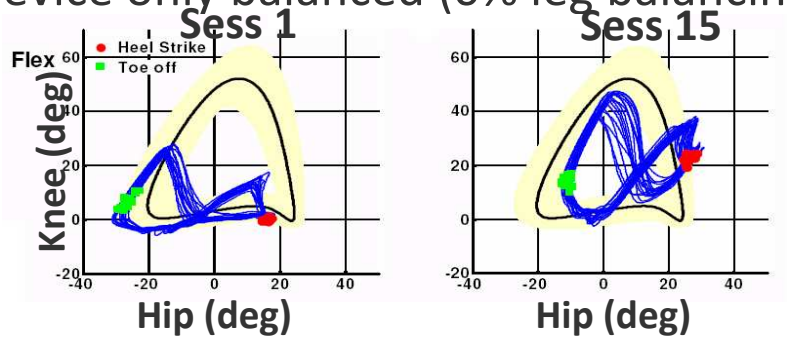
NSF BCS 0745833: 2008-2010

Gait Rehab of Stroke Subjects with Gravity Balancing Exoskeletons

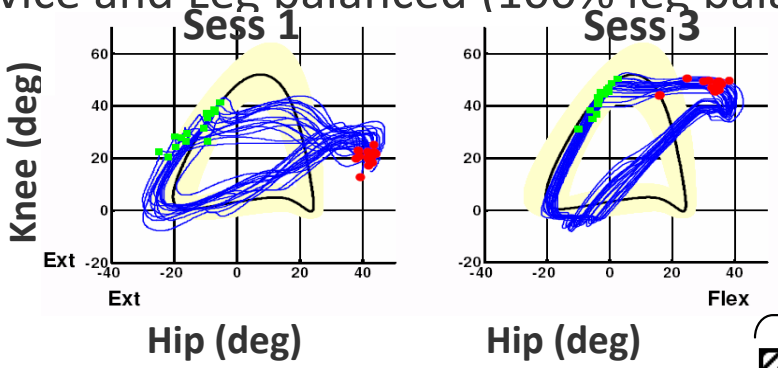
Sunil K. Agrawal, Professor, Univ. of Delaware

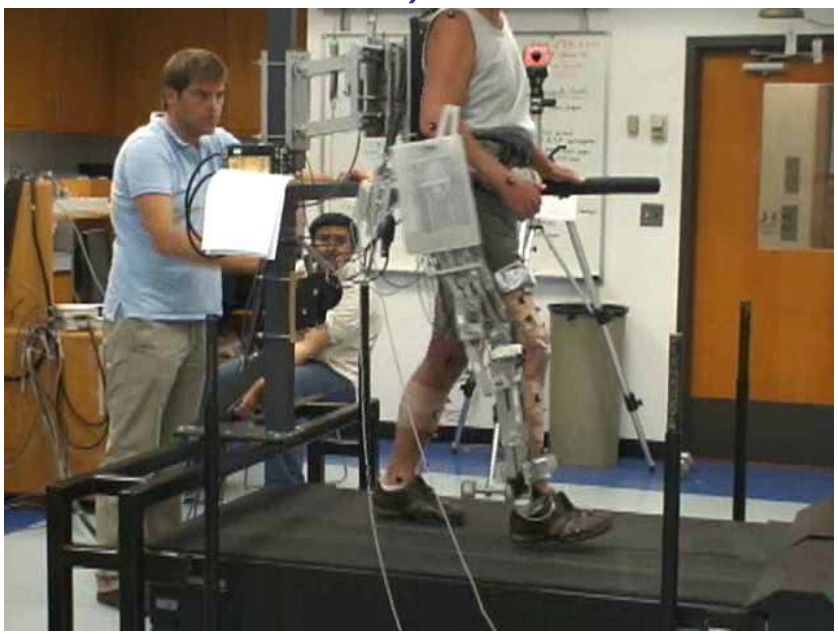
(Funded by NIH R01 HD 038582: 2008-2013)

Device only balanced (0% leg balancing)

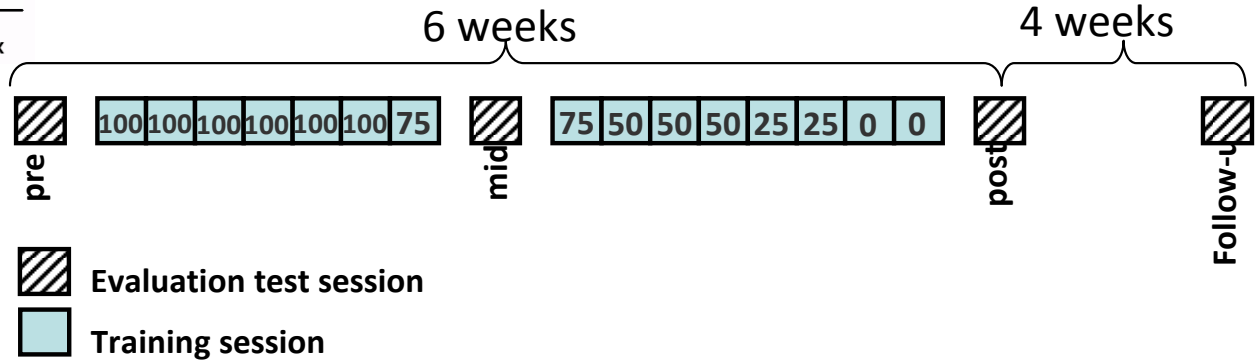


Device and Leg balanced (100% leg balancing)





Gait Training of a Stroke Patient Using a Gravity Balancing Exoskeleton designed at Univ. of Delaware



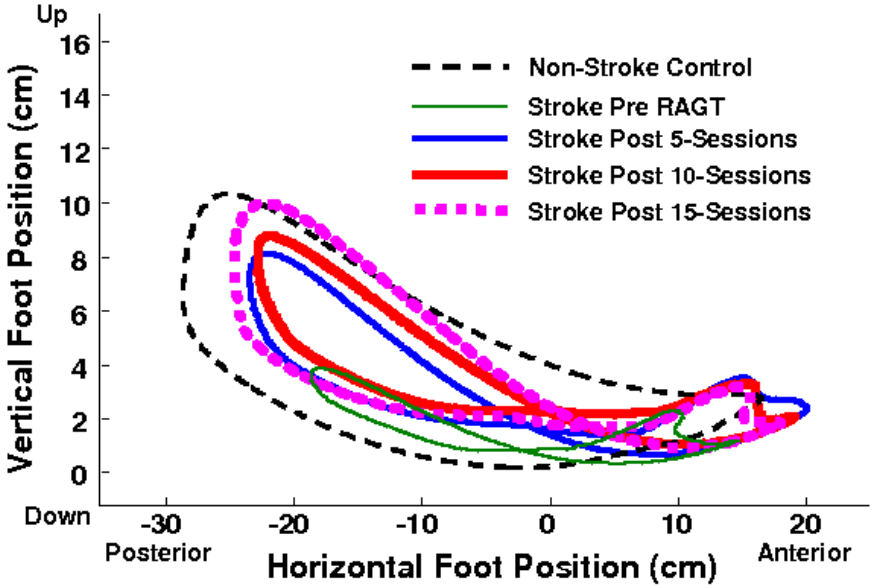
S. Banala, *S. K. Agrawal*, A. Fattah, J. P. Scholz, V. Krishnamoorthy, K. Rudolph, W. L. Hsu, "Gravity Balancing Leg Orthosis and its Performance Evaluation", **IEEE Trans. in Robotics**, Vol. 22, No. 6, 2006, 1228-1239.

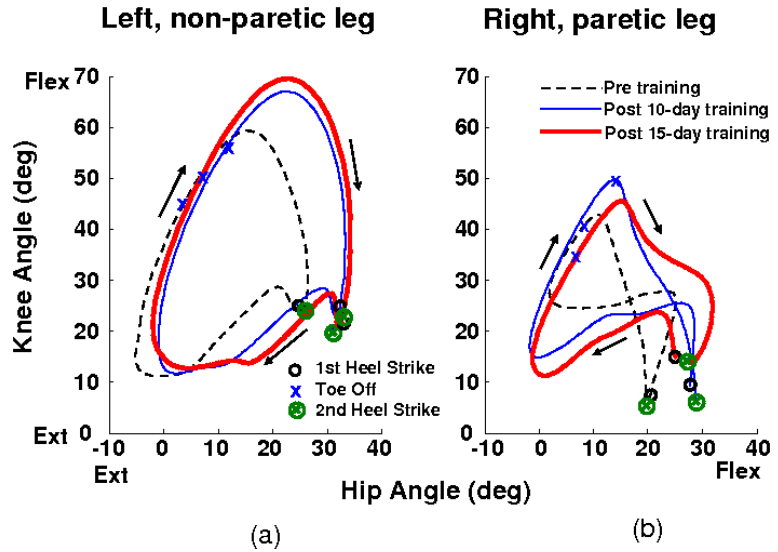
Krishnamoorthy, V., Hsu, W-L, Kesar, T.M., Benoit, D.L., Banala, S.K., Perumal, R., Swangwan V., Binder-Macleod, S.A., *Agrawal, S.K.*, and Scholz, J.P, "Gait Training following stroke: A pilot study combining a gravity-balanced orthosis device, functional electrical stimulation and visual feedback", **Journal of Neurologic Physical Therapy**, Dec. 2008.

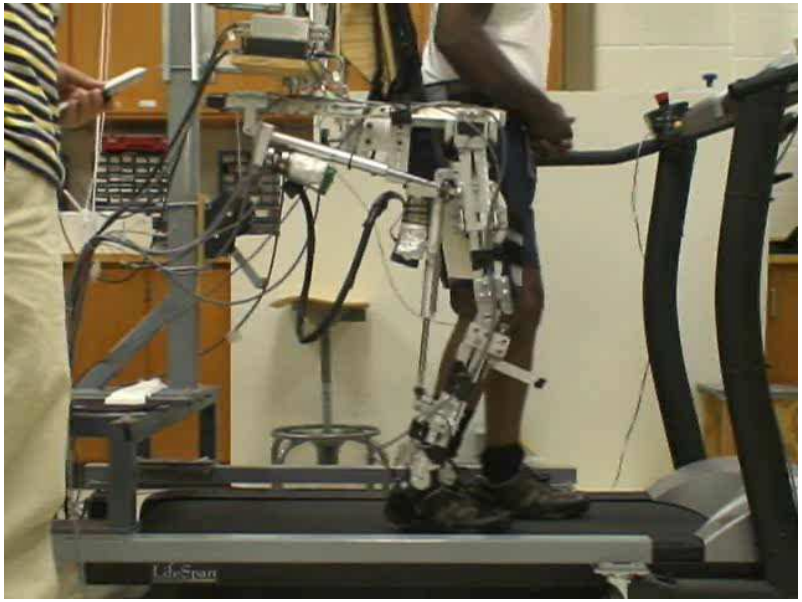
Gait Rehab of Stroke Subjects with Motorized Exoskeletons

Sunil K. Agrawal, Professor, Univ. of Delaware

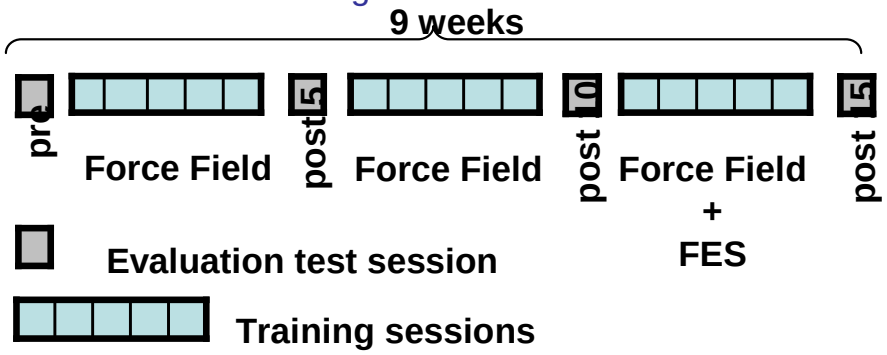
(Funded by NIH R01 HD 038582: 2008-2013)







Gait Training of a Stroke Patient Using an Active Exoskeleton designed at Univ. of Delaware



S. K. Banala, S. H. Kim, S. K. Agrawal, and J. P. Scholz, "Robot Assisted Gait Training with Active Leg Exoskeleton", to appear in **IEEE Trans. on Neural Systems and Rehabilitation Engineering**, 2008.

Societal Implications

- 2-3 Million Stroke survivors in USA
- 700,000 new stroke cases every year
- Improvement of quality of life
- Ambulation and Independence
- Reduce secondary conditions – Fall
- Reduce healthcare costs

Accomplishments to Date

- Pilot demonstrations of effectiveness of robotic technology for gait and other functional rehabilitation
- Numerous studies exist for upper arm movements but gait studies are relatively recent
- Growing awareness of the utility among clinicians

Challenges

- Scientific demonstration of efficacy of robotic protocols for functional training
- Each stroke survivor is different and has specialized needs – How to bring these in robotic exoskeletons?
- Assistive device to Rehabilitative device – continuous wear!
- Cost and affordability …

5/10/20 Year Vision

- 5 Years: Pilot studies and scientific demonstrations
- 10 Years: Translational studies in multiple clinics world-wide
- 20 Years: Acceptance by the medical community as effective rehabilitation solution