http://demotu.org/pubs/FapespNWO2016.pdf

Advances in Biomechanics Applied to Sports

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FAPESP support in numbers* to *"biomecânica" or "controle motor"*

36 Ongoing research grants

363 Completed research grants

61 Ongoing scholarships in Brazil

542 Completed scholarships in Brazil

10 Ongoing scholarships abroad

35 Completed scholarships abroad

1047 **All Research Grants and Scholarships**

***Search on March 12, 2016 @ http://www.bv.fapesp.br/**

Current projects/interests of the Biomechanics and Motor Control Laboratory

- **Balance control in humans (older individuals)**
- **Biomechanics of long distance running and injury mechanisms (non-athletes)**
- **Modeling and simulation of human movement (open software)**
- **Improvement of biomechanical analysis of human movement (clinical use)**
- **Public data sets of biosignals related to human movement (BIG data, worldwide)**
- **Services of clinical gait analysis and wheelchair propulsion analysis (free @ BMClab)**
- **Dissemination of science and mathematics to society using sports (La Fisica del Calcio)**

Biomechanics of long distance running
Biomechanics and Motor Control Laboratory

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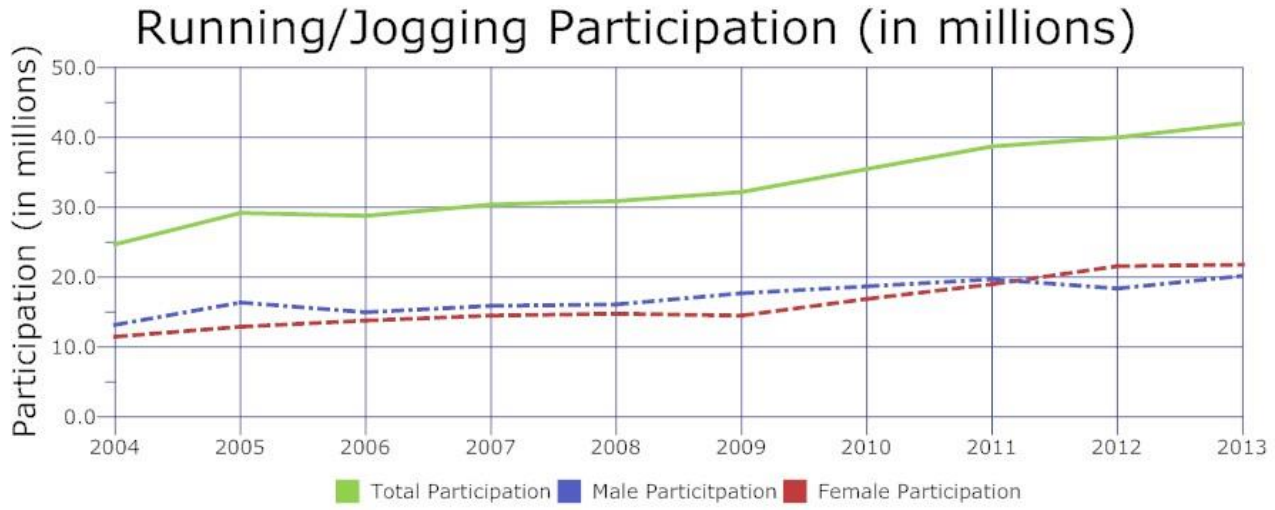
Background

- **Increased running participation**
  - **Brazil: ~4.5 million runners (anecdotal evidence)**
  - **USA: ~30 million[1]**
  - **Increased older runners' participation[2] (healthy aging)**



	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Total Participation	24.7	29.2	28.8	30.4	30.9	32.2	35.5	38.7	40.0	42.0
Male Particitpation	13.2	16.4	15.0	15.9	16.1	17.7	18.7	19.7	18.4	20.2
Female Participation	11.5	12.9	13.8	14.5	14.8	14.5	16.9	19.0	21.6	21.8

[1]http://www.runningusa.org/
[2]Jokl et al. (2004) BJSM.

Background

- **Running injury frequency between 15-85%[1]**
- **Economic burden of a running injury[2]**
  - **Direct cost €57.97**
  - **Indirect costs €115.75**
- **Older age has been associated with higher incidence[3]**

[1]Nigg et al. (2015) BJSM; [2]Hespanhol et al. (2015) SJMSS; [3]Nielsen et al. (2013) OJSM.

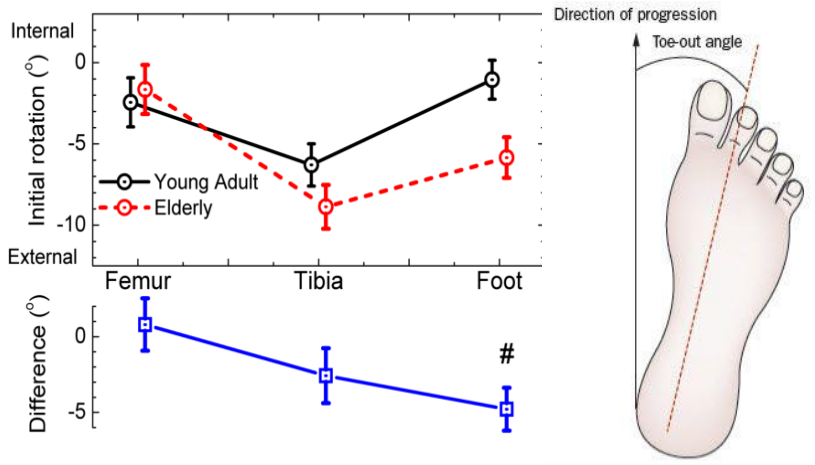
Background

- **Running injury etiology is likely multifactorial[1]**
  - **Epidemiological data**
  - **Biomechanical studies**
  - **Clinical research**
  - **Behavioral research**
- **Atypical running patterns have been associated with injuries[2]**
- **Age-related changes in running biomechanics have been consistently observed[3,4]**

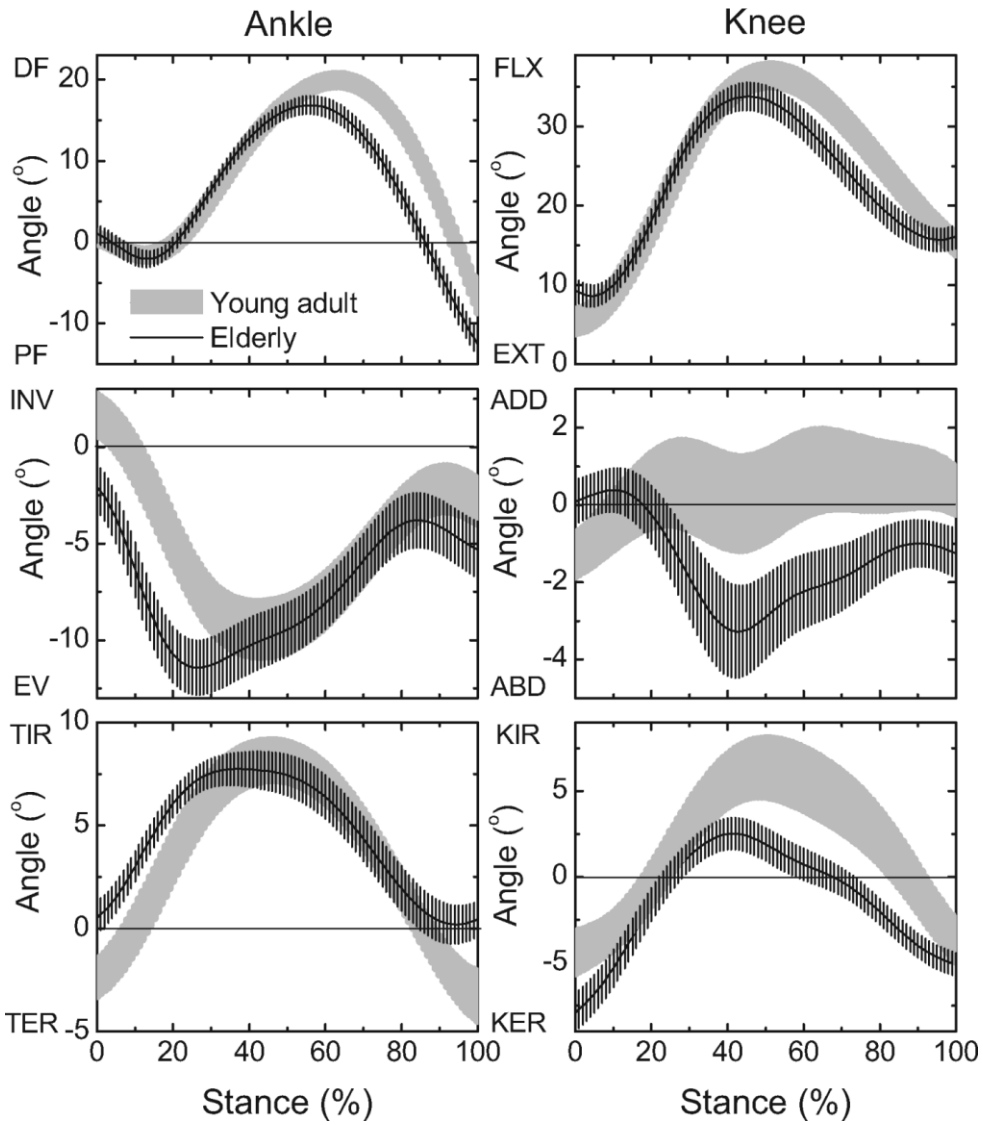
[1]Hulme and Finch (2016) JSHS; [2]Hreljac (2004) MSSE; [3]Fukuchi and Duarte (2008) JSS; [4]Fukuchi et al. (2014) CB.

Aging & biomechanics of long distance running

- ⬇ stride length
- ⬆ stride frequency
- Altered joint kinematics

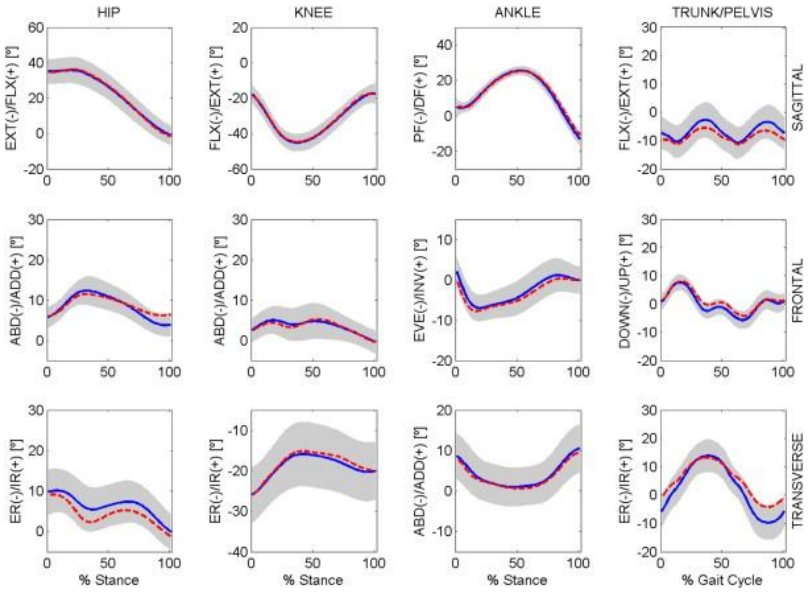


Fukuchi & Duarte (2008)

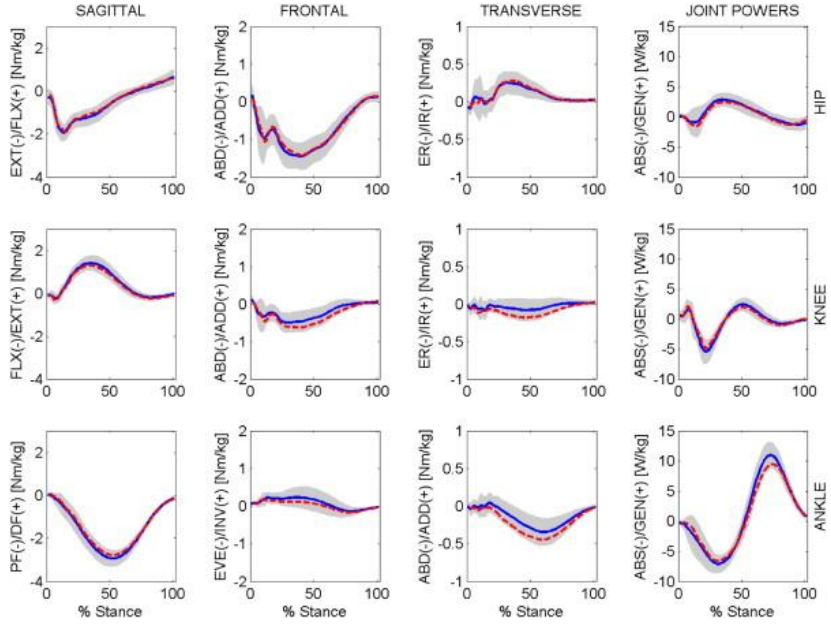


Aging & biomechanics of long distance running

- ⬇ flexibility and ⬇ muscle strength in older runners
- Atypical gait in older runners



Kinematics

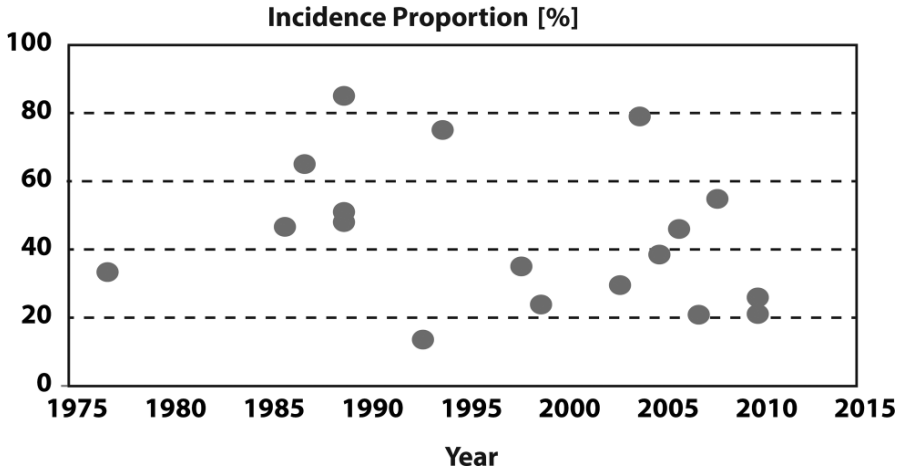


Kinetics

Fukuchi et al. (2014)

The Problem

- **Despite intense research the injury rates have not declined[1]**

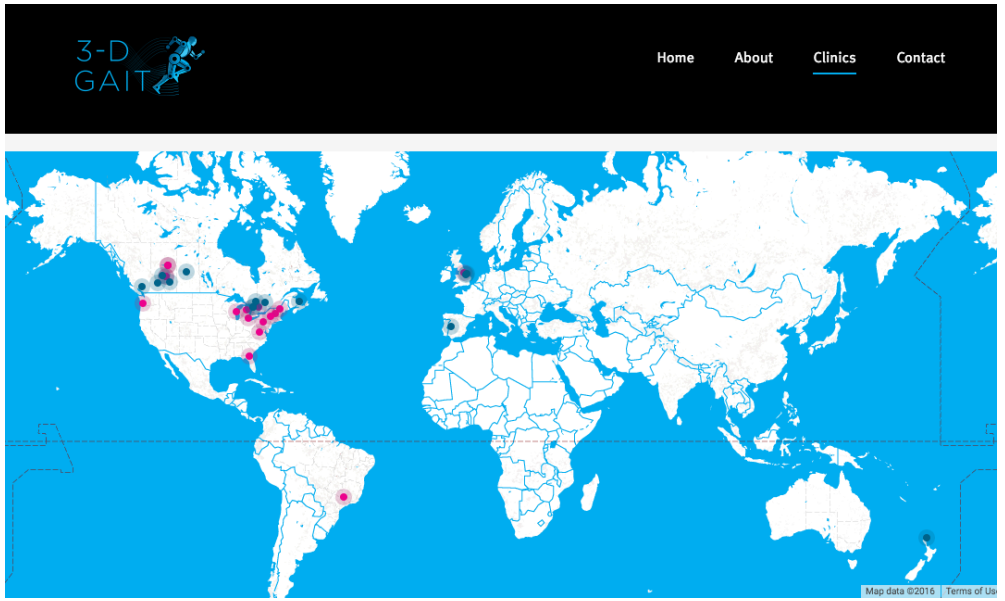


- **Complex nature of running biomechanics data has been examined by simplistic approaches[2]**
- **What is the typical and atypical (injured) running pattern?**

[1]Nigg et al.(2015) BJSM; [2]Chau (2001) GP; [3]Mullineaux et al. (2001) JSS.

Possible approach for a solution

- **A public database of running ranging from demographics, biomechanical, musculoskeletal function and epidemiological data with a large population of runners.**



http://3dgaitanalysis.com/

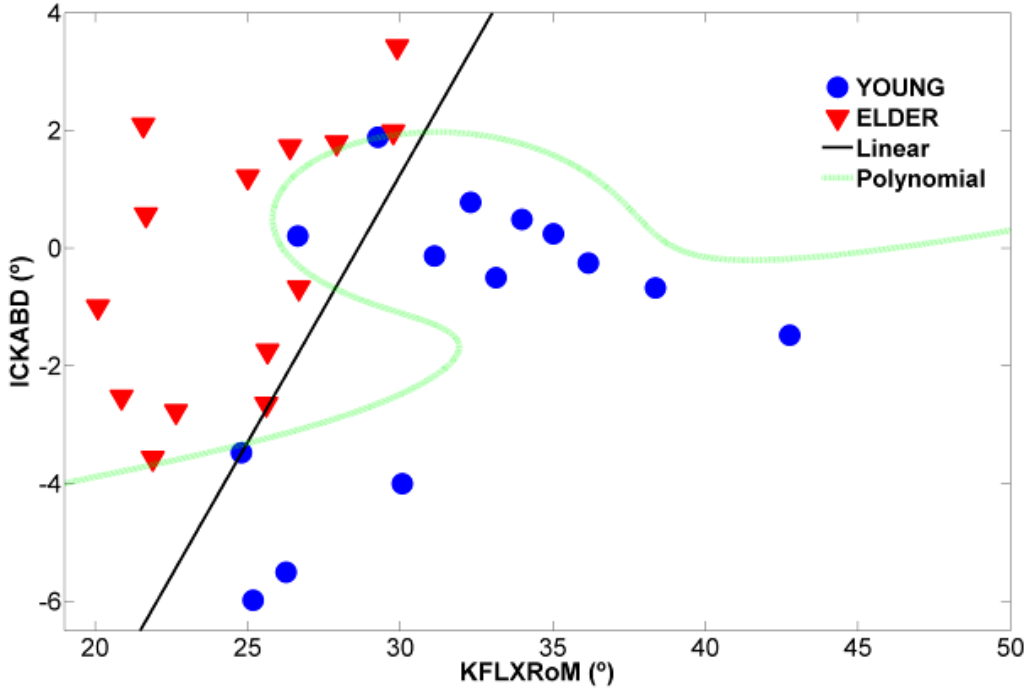
Public running database

- To provide good quality data to the scientific community

- Development and testing of novel and robust data analysis approaches to address the complex, multivariate nature of running injuries etiology

http://mobilize.stanford.edu

Aging & biomechanics of long distance running



- **85% overall classification accuracy rate**
- **100% classification accuracy rate was achieved when only six kinematic features were combined**

Fukuchi et al. (2011)

Biomechanics of long distance running
Biomechanics and Motor Control Laboratory

- But there are still too many unsolved problems with the biomechanics of long distance running and injury mechanisms …

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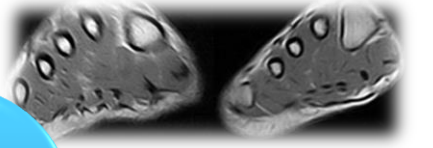
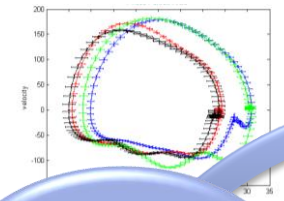
Physical Therapy, Speech, Occupational Therapy dept.
LaBiMPH
Laboratório de Biomecânica do Movimento e Postura Humana

Engenharia Biomédica
UFABC

Aim - Investigate the effects of :
(1)a "ground-up" therapeutic approach and
(2)aging on…
… running and gait biomechanics, on lower limbs coordination, on strength and functionality of the muscles of the lower limbs and on the prevention of running-related injuries.





Foot muscle trophism

Run & walk biomechanics

Coordination of inter and intra limbs

Long-distance runners (adt & elderly)

Running-related injury

Foot health & functionality

Foot-ankle and toes strength

2 months supervised sessions

10 months home-exercises

12 months assessments

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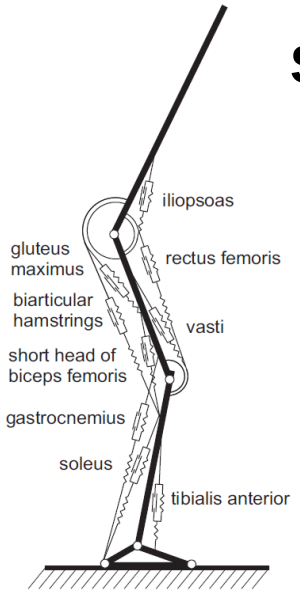
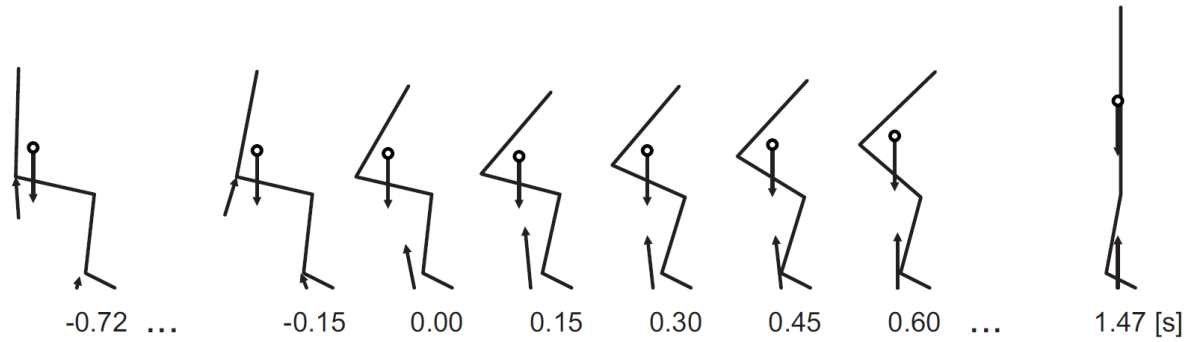
(some) Collaborators in São Paulo State

Optimal Control of Human Movement

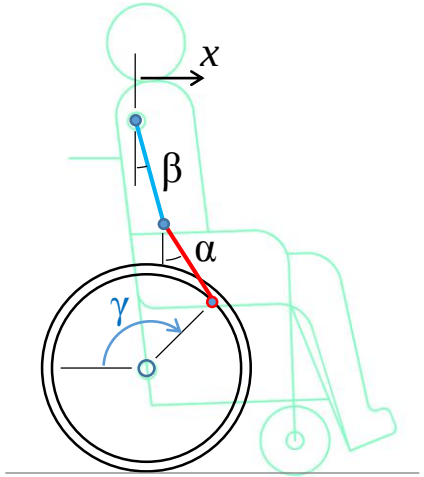
- ***Marko Ackermann – FEI University, São Bernardo do Campo, Brazil***
- ***Maarten F. Bobbert – VU University Amsterdam, The Netherlands***

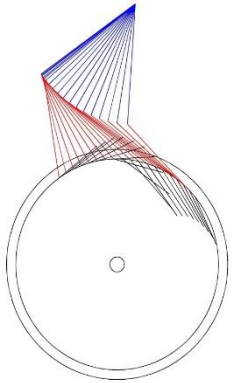


Sit-to-stand task *(CNPq Project: 402831/2012-8, Marco Vaz, PA)*



Wheelchair propulsion

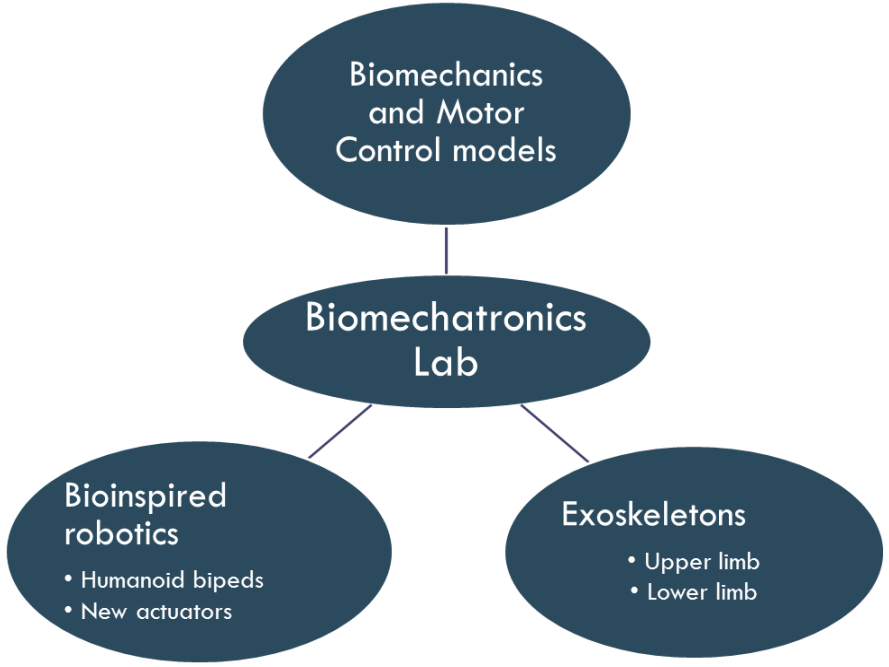




BIOMECHATRONICS LAB.
MECHATRONICS DEPARTMENT
ESCOLA POLITÉCNICA. UNIVERSITY OF SÃO PAULO

Biomechatronics = Biomechanics + Motor Control (Natuurlijk! –F.C.T. vd Helm-)

Models of the human motor control system from a control engineering perspective



http://sites.poli.usp.br/pmr/biomecatronica/

- Faculty:

Arturo Forner-Cordero
Rafael T. Moura

- Post-docs

Fabianne Furtado

- PhD

Luis Filipe Rossi
Carlos Noriega
Milton Cortez Junior
Guilherme Umemura

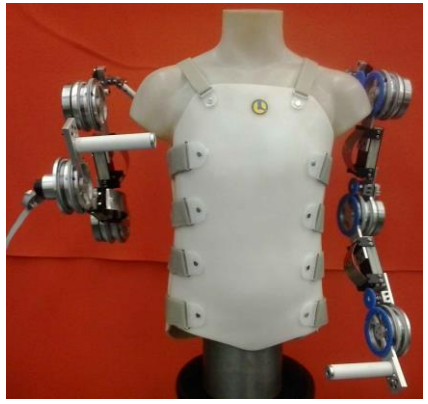
- Visiting Professors (NL):

Jacques Duysens (CNPq)
Bouwien Smits-Engelsman
Noel Keijsers

- MSc students

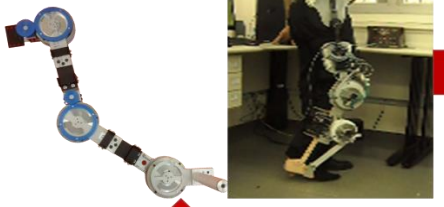
Camila Souit
Mayra B. Villalpando
Rafael S. Souza
Eduardo Garcia
Leonardo F. Sommer
Michele Sakata

BIOMECHATRONICS LAB. (A. FORNER-CORDERO)



Exoskeleton

Miranda et al, 2012



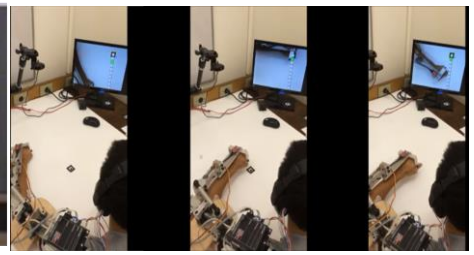
Assist

Human

Da Vinci L, 1490

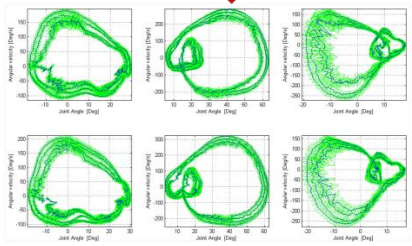
Measure

Tripping humans for science



Forner-Cordero et al,
Gait&Posture, 2003
J. Biomech., 2006

Analyze

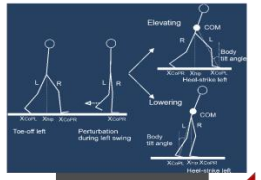


Experimental Limit Cycles of human gait used to define stability limits

Gallego et al, 2012

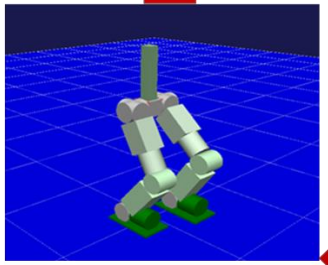
Models

Forner Cordero et al, 2004

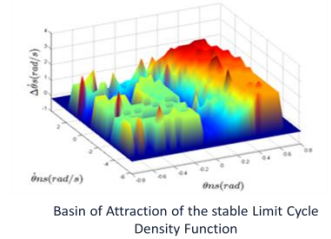


Design

Rossi et al, 2014

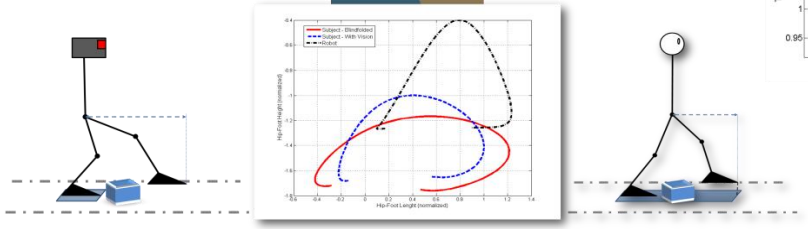


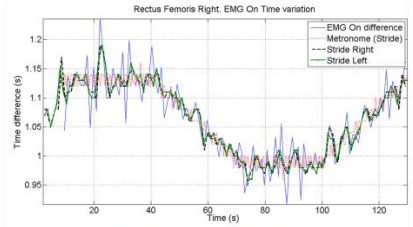
Robots



Basin of Attraction of the stable Limit Cycle Density Function

Rossi et al, 2014





Forner-Cordero et al, 2014

Forner-Cordero A; Rodrigues ST; Duysens J. Obstacle crossing differences between blind and blindfolded subjects after haptic exploration. J Motor Behavior (in press)

Forner-Cordero A; Itiki C; Souza R; Lourenco JCMC; Krebs HI (2014). Experimental assessment of gait with rhythmic auditory perturbations. BioRob2014

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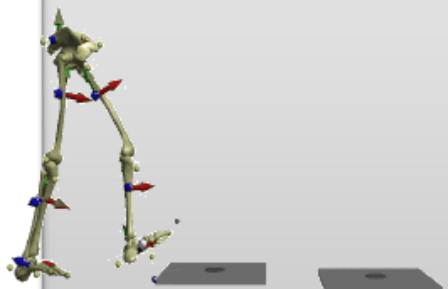
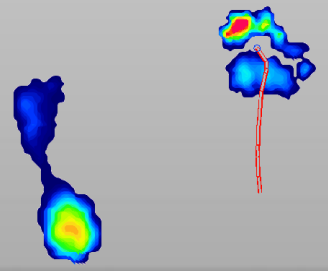
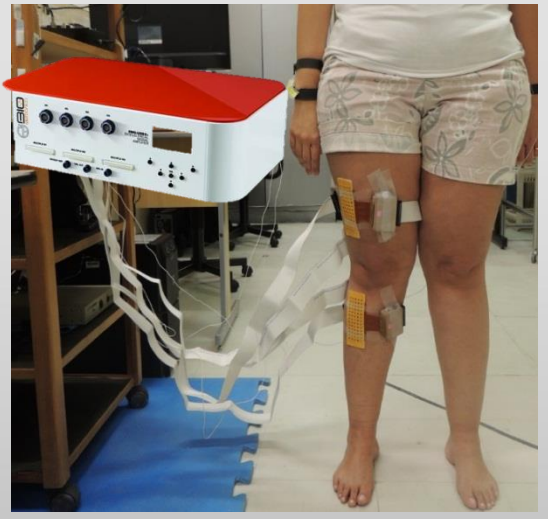
Diabetic Neuropathy

Kinematics, Kinetics, Plantar pressure

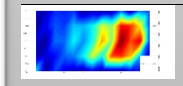


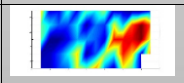


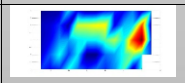
sEMG multichannel

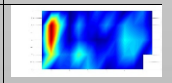


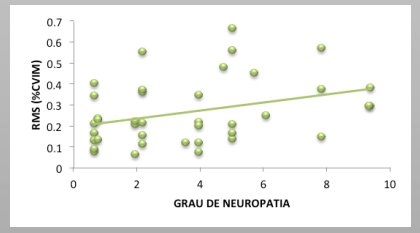
CONTROLE	AUSENTE	INTERMEDIÁRIO	GRAVE



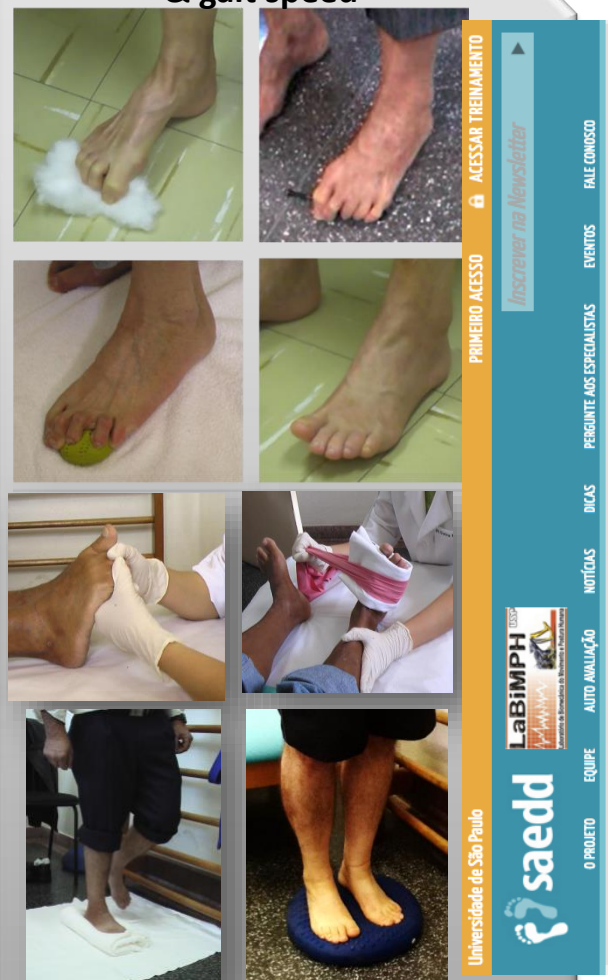








RCT Effect foot exercises in PP & gait speed



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Obrigado

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