Welcome!

OpenSim Europe Workshop
Bologna, 3-5 February 2016
Rizzoli Orthopaedic Institute Research Center - Aula 2

Advance your projects in musculoskeletal modeling and simulation of movement using OpenSim

Welcome!
Agenda : February 3\textsuperscript{rd}

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
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<tbody>
<tr>
<td>8:30 – 9:00</td>
<td>Reception and check OpenSim installation</td>
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<tr>
<td>9:00 – 10:00</td>
<td>Introducing workshop, faculty and participants</td>
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<td>\textit{Giordano Valente}</td>
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<tr>
<td>10:00 – 10:30</td>
<td>Musculoskeletal modeling in OpenSim - Use and application</td>
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<td>\textit{Luca Modenese}</td>
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<td>10:30 – 11:00</td>
<td>Data import, marker set definition, and scaling</td>
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<td>13:00 – 14:00</td>
<td>Lunch</td>
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<td>Inverse Kinematics</td>
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<td>\textit{Friedl De Groote}</td>
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<td>\textit{Work on your own project}</td>
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<td>19.30 – 21.30</td>
<td>\textit{Wine &amp; Food Tasting}</td>
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Agenda : February 4th

9:00 – 9:30  Residual Reduction Algorithm  
Mariska Wesseling

9:30 – 11:00  Work on your own project

11.00 – 11:30  Coffee Break

11.30 – 12.00  Static Optimization  
Massimo Sartori

12:00 – 12:45  Work on your own project

12:45 – 13.30  Lunch

13:30 – 15:00  Visit laboratories and monumental area

15:00 – 15:30  Forward simulation  
Massimo Sartori

15:30 – 16:00  Work on your own project

16:00-16:30  Coffee Break

16:30 – 17:00  Computed Muscle Control  
Friedl De Groote

17.00 – 17.30  Work on your own project

17.30 – 18.00  Teleconference with OpenSim team

19.00 – 20.30  Visit ancient underground Bologna
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<td>9:00 – 9:30</td>
<td>Joint Reaction Analysis + Induced Acceleration Analysis</td>
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<td><em>Giordano Valente + Ilse Jonkers</em></td>
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<td>About model/simulation validation</td>
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<td><em>Ilse Jonkers</em></td>
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<td>12:45 – 13.30</td>
<td>Lunch</td>
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<td>13:30 – 14:00</td>
<td>Prepare your project presentation</td>
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<td>14:00 – 15:00</td>
<td>Participants’ presentations</td>
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<td>15:00 – 15:30</td>
<td>Closing</td>
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OpenSim

https://simtk.org/home/opensim

http://opensim.stanford.edu
Elements of a Musculoskeletal Simulation
Purpose of modeling and simulation

- Visualize complex movement patterns
- Probe parameters that are difficult to measure
- Perform “what if” studies
- Identify cause-effect relationships
Visualize human running in detail
Probe the function of a muscle
OpenSim is an application
OpenSim is a modeling platform

Deformation-Based Contact Forces
- Hunt-Crossley for analytical shapes
- Elastic foundation for an arbitrary mesh
OpenSim is a modeling platform

Muscle Actuators
OpenSim is a modeling platform

Controllers
OpenSim is a set of tools

Importing and Previewing Motion Data
OpenSim is a set of tools

Scaling Musculoskeletal Models
OpenSim is a set of tools

Inverse Kinematics and Inverse Dynamics
OpenSim is a set of tools

Estimation of Muscle Forces:
Static Optimization and Computed Muscle Control
OpenSim is a set of tools

Forward Dynamics
OpenSim is a set of tools

Analyses: Induced Accelerations and Joint Reactions
OpenSim is an extensible software framework

- OpenSim Graphical User Interface (GUI)
  - GUI Scripts
  - Matlab Scripts
  - Command Line Tools
  - C++ Plugins

OpenSim Modeling and Simulation Libraries

Simbody Dynamics Engine

OpenSim Workshop
OpenSim is a resource

http://opensim.stanford.edu
OpenSim is a worldwide community

86702 Page Hits in the past 180 Days (9742 Unique Visitors)
2345 Stanford Page Hits (81 Unique Visitors)
OpenSim is a team of contributors:

Scott Delp  Ayman Habib  Jennifer Hicks  Jeff Reinbolt  Ajay Seth  Michael Sherman

Edith Arnold  Matt DeMers  Sam Hamner  Chand John  Kat Steele  Melanie Fox  Peter Eastman

Clay Anderson  Allison Arnold  Eran Guendelman  May Liu  Peter Loan  Darryl Thelen  You!
Objectives for the Workshop

• Gain more insight in the Opensim workflow using your own motion capture data:
  – Learn the underlying theory, best practices, and troubleshooting tips for IK, ID, RRA and CMC through hands-on practice
  – Learn techniques for data management OpenSim in your own research
  – Become confident in your data workflow

• Achieve your project goals and share your results

• Advance your research!
The Workshop Software

- OpenSim 3.3
Getting the most out of the workshop:

- Set clear and manageable project goals
- Help each other
- Use your resources: lectures and online materials
- Still need help? Find the right person to ask your questions
- Have fun and take breaks
How we hope you will respond:

- Continue to use OpenSim in your research

- Develop musculoskeletal models and contribute them to the biomechanics community

- Use OpenSim in your teaching and contribute new teaching materials

- Add features to the software and share with others
**Additional info**

**Lunch**

Suggestion: Cafeteria down the stairs

**Social Events**

- Wine&Food Tasting:
  7.30pm Enoteca Italiana - Cost 25 Euros
  Collect money at lunch break today

- Visit Underground Bologna
  Tomorrow 7pm Pincio Stairs – Cost 10 Euros
  Collect money at lunch break tomorrow
OpenSim Europe Workshop
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Rizzoli Orthopaedic Institute Research Center - Aula 2

Advance your projects in musculoskeletal modeling and simulation of movement using OpenSim

Faculty Introduction
Giordano Valente
Postdoctoral Researcher
Rizzoli Orthopaedic Institute
Medical Technology Laboratory

2012: PhD in Bioengineering (University of Bologna)
2012: Visiting Scholar KU Leuven

Research Interest:
Computational models of the musculoskeletal system from
clinical data to study human movement dynamics and lower-limb
skeletal loading.

Applications relate to:
Orthopaedic diseases (skeletal reconstructions, dysplasia,
osteoarthritis)

Goal is to:
Improve surgical planning and rehabilitation protocols.
Ilse Jonkers
Associate Professor KU Leuven
Human Movement Biomechanics Group

2000: Phd in Rehabilitation Sciences (KU Leuven)
2000-2009: Postdoctoral Researcher (KU Leuven)
2004-2006: Visiting Scholar Stanford University

Research Interest:
I want to understand the neuromuscular constraints of gross motor function and relate gross motor function, joint and tissue loading to musculoskeletal adaptation.

Applications relate to:
• the understanding of joint and implant loading (UL&LL)
• the remediation of gait disorders in CP and stroke patients.
Goal is to:
• optimize rehabilitation strategies and surgical interventions.
Friedl De Groote
Postdoctoral researcher KU Leuven
Department of Kinesiology
Human Movement Biomechanics Research Group

2009: PhD in Mechanical Engineering (KU Leuven)

Research Interest:
Development of computational models and methods to study human motion that are sufficiently accurate and numerically efficient to be used for outcome prediction of neuro-orthopedic treatments and rehabilitation/training programs.

Applications relate to:
• treatment of gait disorders in CP patients,
• design and control of active orthotics.

Goal is to:
• optimize clinical outcome and performance.
Mariska Wesseling
Postdoctoral researcher KU Leuven
Human Movement Biomechanics Research Group

2015: PhD in Biomedical Science (KU Leuven)

Research Interest:
To study factors that affect joint loading and the subsequent effect on the tissue, to be able to determine the effect of interventions non-invasively.

Applications relate to:
• Treatment of joint disorders (e.g. osteoarthritis)

Goal is to:
• Determine the effect of interventions non-invasively
Massimo Sartori
Postdoctoral Fellow
University Medical Center Göttingen (UMG)
Institute of Neurorehabilitation Systems
   PhD in Information Engineering (University of Padova)
2012: Postdoctoral Fellow at UMG
2013: Visiting Scholar at Stanford
2014: OpenSim Fellow

Research Interest:
Computational methods for bridging between the neural and the
functional understanding of human movement in healthy and
impaired individuals.

Applications relate to:
• Intuitive human-machine interfaces.

Goal is to:
• Patient-specific neurorehabilitation treatments and technologies.
Luca Modenese

Postdoctoral Research Associate
INSIGNEO institute for in silico medicine
University of Sheffield

2013: PhD in Biomechanics (Imperial College London)
2013-2015 PostDoc at Centre for Musculoskeletal Research (GU)
2013: Visiting Scholar Stanford University

Research Interest:
Building subject specific musculoskeletal models from medical images.

Applications relate to:
Identification of pathology and discrimination of clinical outcomes in (neuro-)musculoskeletal diseases (juvenile idiopathic arthritis, cerebral palsy).

Goal is to:
Improve clinical evaluation and rehabilitation protocols.
Additional Support

Lorenzo Pitto
Research Assistant
Rizzoli Orthopaedic Institute