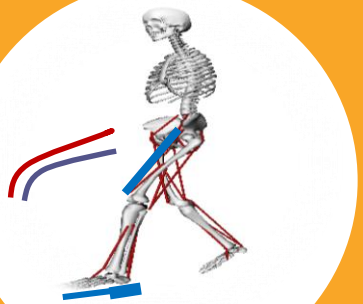
Muscle Force Estimation for Personalized Musculoskeletal Model



HIROSHIMA UNIVERSITY

- Creation of personalized musculoskeletal Model
- Muscle force and activation estimation with external assistive muscle

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2016/1/18

Assistive Muscle

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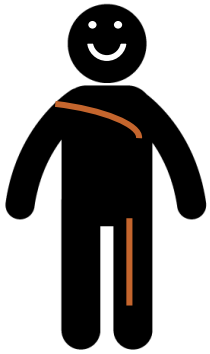
External Assistive Muscle



- External Source of strength for human
- Improves physical capabilities
- Active or Passive

Application

- Health Care and rehabilitation
- Work involved lifting heavy items
- Sports

Advantages

- Reduces stress on human muscle
- Faster recovery
- Reduces muscle fatigue
- Improve Performance in sports

Problem for testing Assistive Muscle

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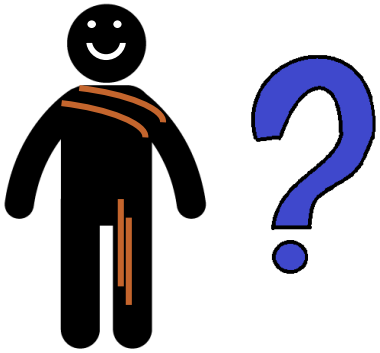
Placement → Effects → Strength Regulation

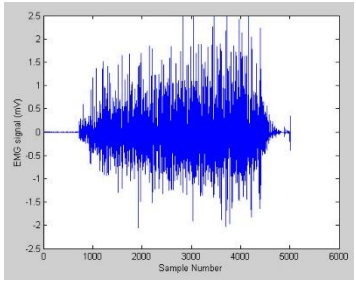


- Ability to see improvement in muscle force generation
- Reduced muscle fatigue level
- Muscle activation
- Changes in DOF

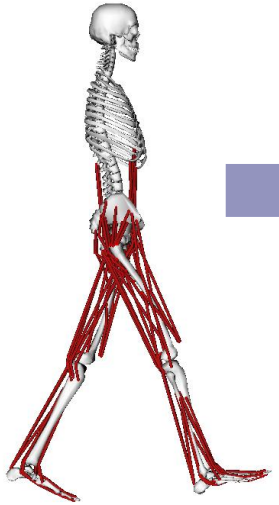
- Find out endpoints to increase muscle strength in % (i.e. 10 %, 20% …) of the individual muscle strength

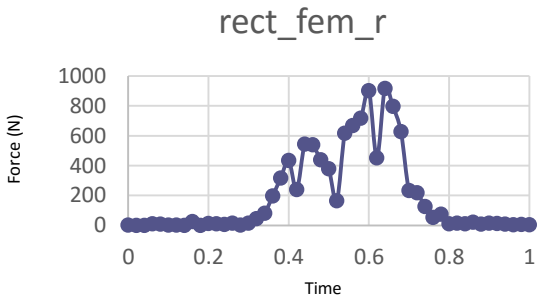
Conventional Methods vs Simulation

- Traditional Method to use emg sensor to find muscle strength and fatigue level for muscles in respective motion.



- Use OpenSim to simulate model, motion, external force, to test the results of using assistive muscle





Research Introduction – Simulation

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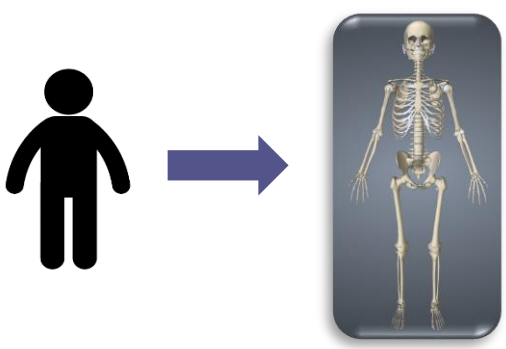
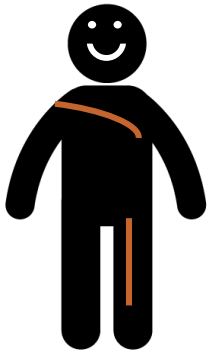
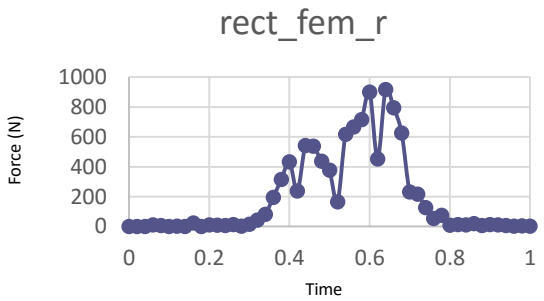
Personalized Musculoskeletal Model → Attach Assistive Muscle → Estimation of Muscle Force and Activation







- Build personalized musculoskeletal model
- Properties used are
  - Height
  - Weight
  - Bone lengths
  - Etc…

- Simulate adding assistive muscle to personalized model
- Reconfigure the model with muscle properties

- Online Static optimization for the given motion
- Changes are reflected in the online graphs
- Data validation

Development Personalized Musculoskeletal Model

- Opensim SDK
  - SimBody API
  - SimTK API
- Create new model customized for individual parameters.

Example:
Fig A and Fig B are model for short and tall human. While creating new model changes in the properties takes place.
Such as

- Bone lengths
- Joint Angles
- Center of mass
- Muscle length
- etc..

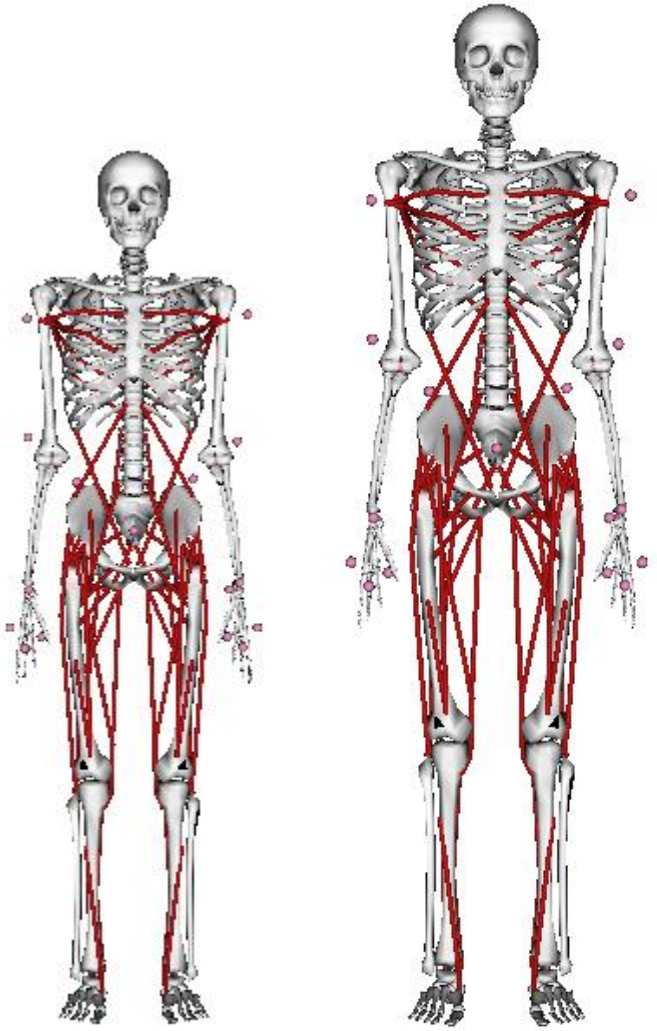
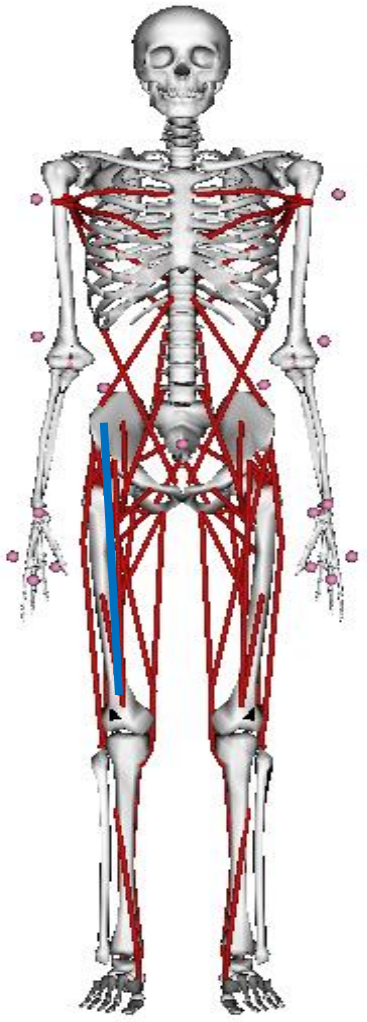


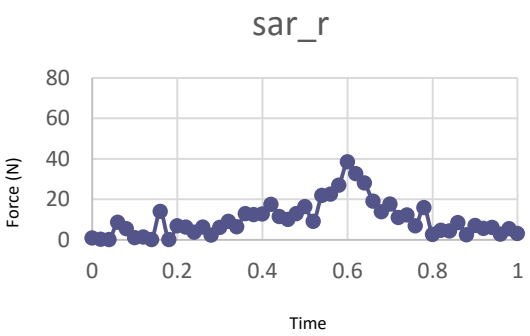
Fig A Fig B

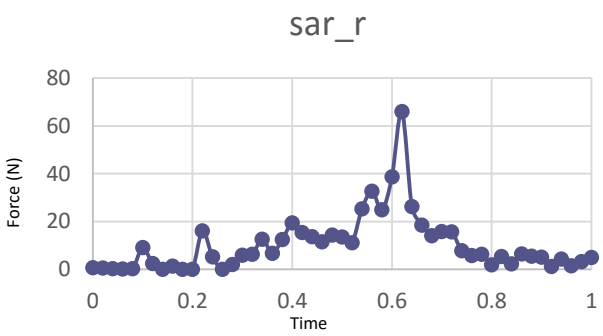
Assistive Muscle and Static Optimization

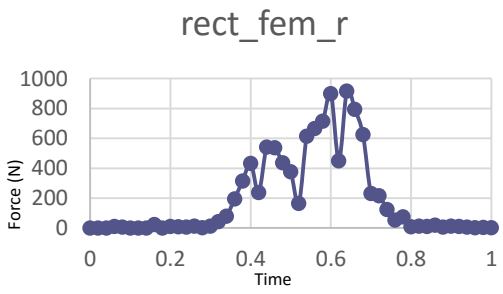


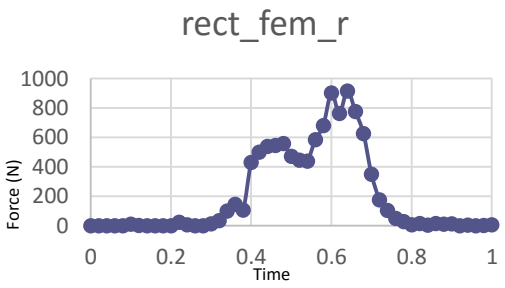
Muscle Force generation without and with assistive muscle

Without Assistive Muscle	With Assistive Muscle









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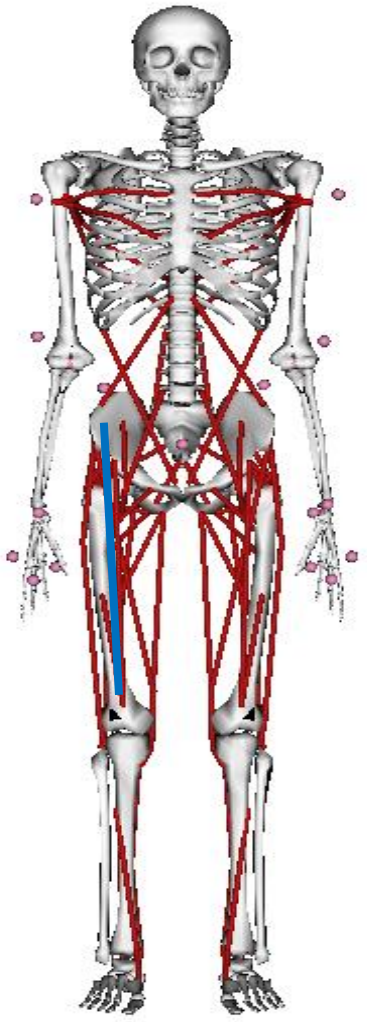
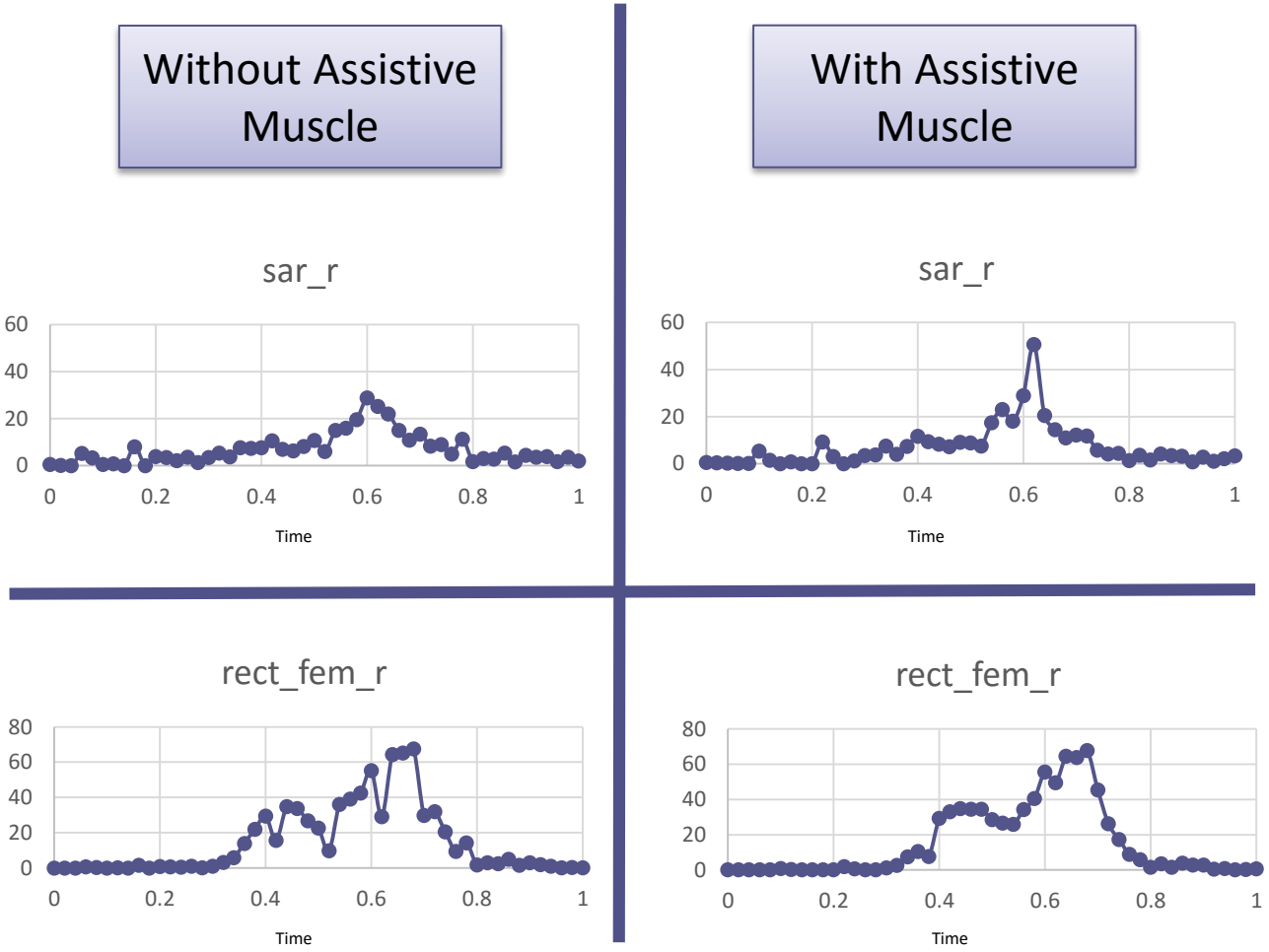


Muscle activation without and with assistive muscle



Learnings and Further Research

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Learnings:

- Opensim to simulate the musculoskeletal model, motion
- Static optimization tool for muscle force and activation
- OpenSim API
  - To create musculoskeletal model
  - Perform static optimization
  - Update model properties
  - Etc…

Further Research:

Write tool to simulate real time changes for following action using Opensim/SimTK Infrastrucutre

- Build personalized musculoskeletal model
- Attach assistive muscle to the model
- Show online muscle force generation and activation