NEURAL INFORMATION PROCESSING SYSTEMS

MyoChallenge 2024:

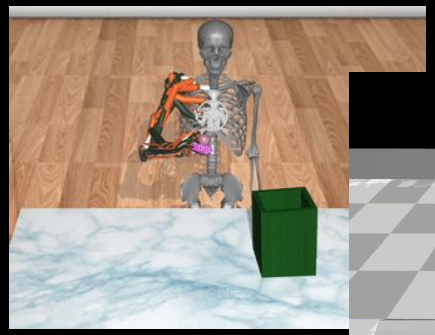
A New Benchmark for Physiological Dexterity & Agility in Bionic Humans

Cheryl Wang, Chun Kwang Tan, Balint K Hodossy, Shirui Lyu, Pierre Schumacher, James Heald, Kai Biegun, Samo Hromadka, Maneesh Sahani, Gunwoo Park, Beomsoo Shin, JongHyun Park, Seungbum Koo, Chenhui Zuo, Chengtian Ma, Yanan Sui, Nicklas Hansen, Stone Tao, Yuan Gao, Hao Su, Seungmoon Song, Letizia Gionfrida, Massimo Sartori, Guillaume Durandau, Vikash Kumar, Vittorio Caggiano

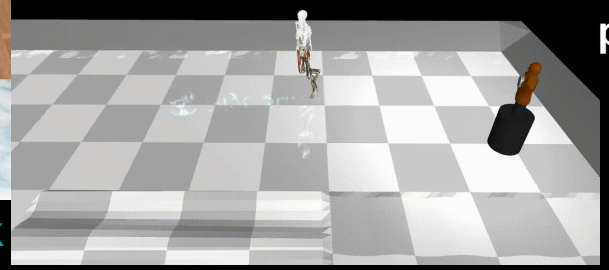
The movement generalization and environment adaptability skills displayed by humans with prosthetic extension are a testament to motor intelligence, a capability yet unmatched by current artificial intelligence.

Get the community together to solve real world dexterity problems and solving them with the same constraints of human actuation

MyoChallenge Series @ NeurIPS



Manipulation Track



Locomotion Track

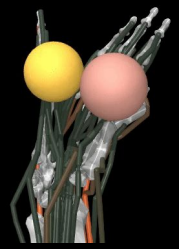
We created the first open-source, scalable platform for co-simulating electromechanical and biomechanical systems

Physiological Dexterity and Agility in Enhanced Humans

Learning Physiological Dexterity

2022

Die Rotation

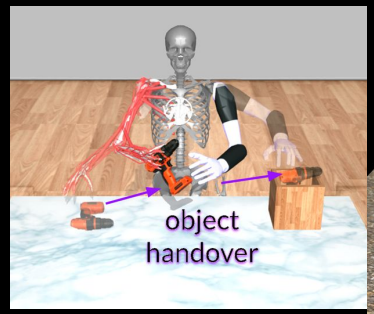


Baoding Balls

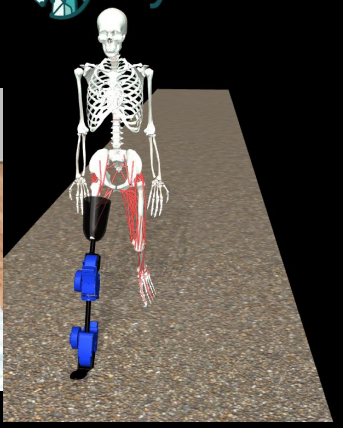
Towards Human-Level Dexterity and Agility

2023

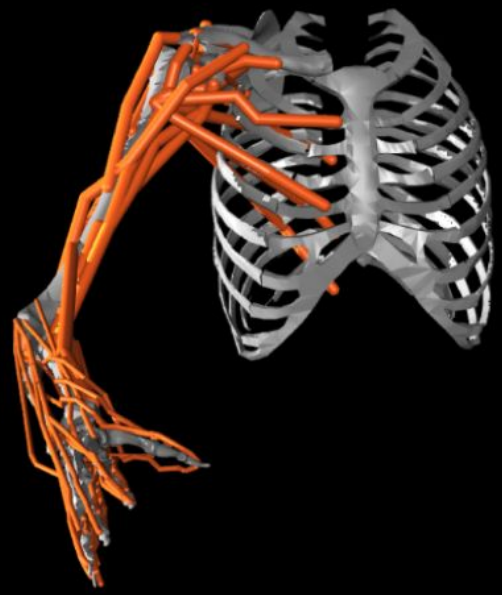
2024



MyoSuite



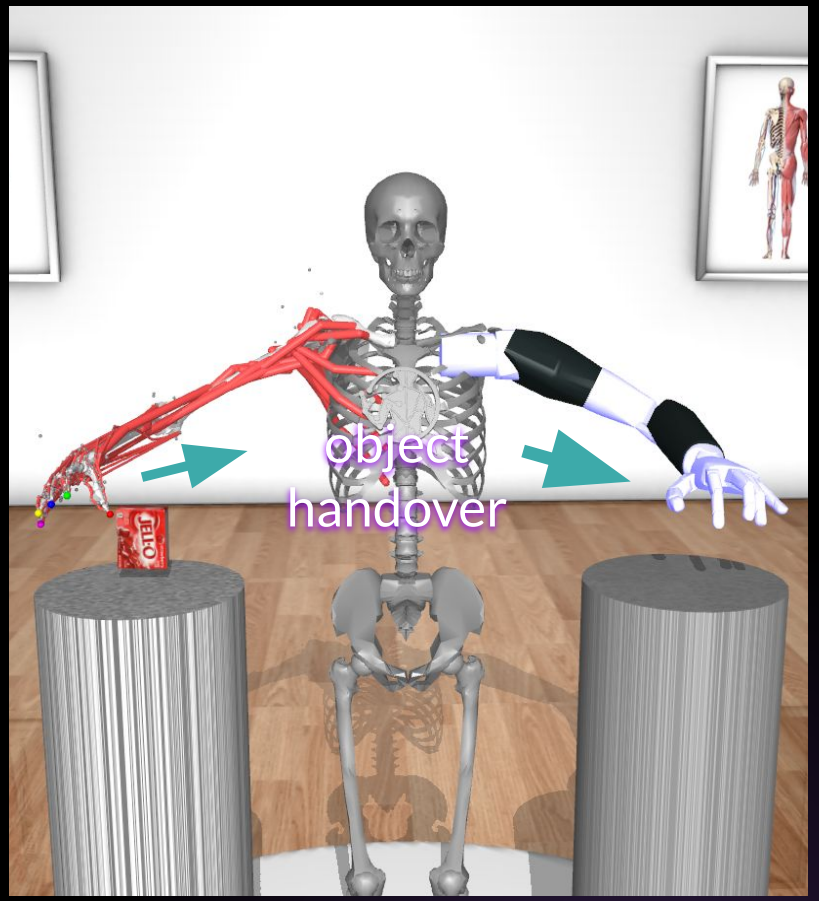
Track 1 – Bionic Co-manipulation



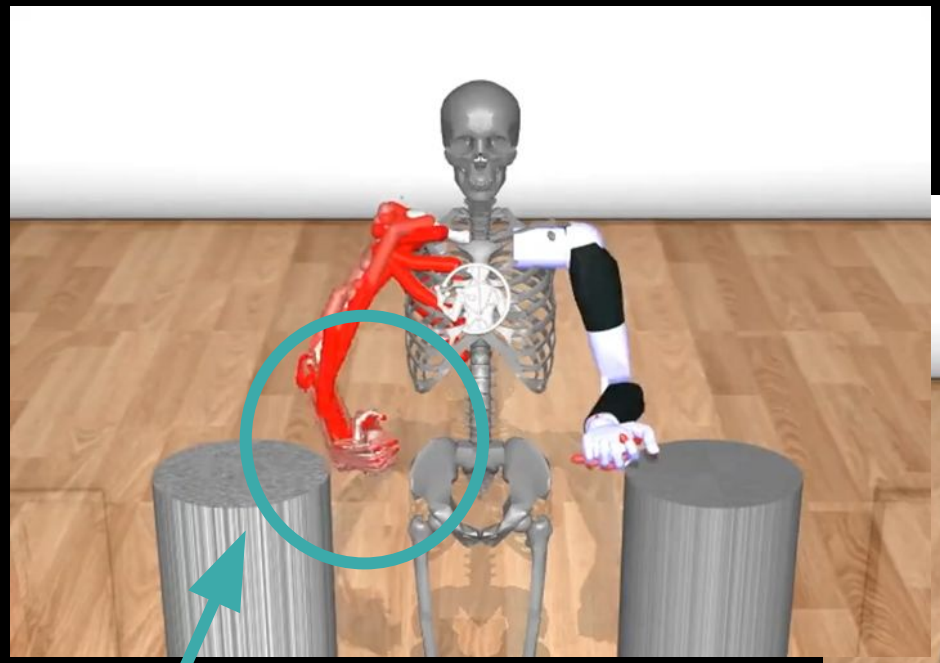
MyoArm
63 muscles
27 Degree of Freedom (DoF)

MyoMPL
17 actuators
26 Degree of Freedom (DoF)

Modular Prosthetic Limb (MPL)
from Johns Hopkins University

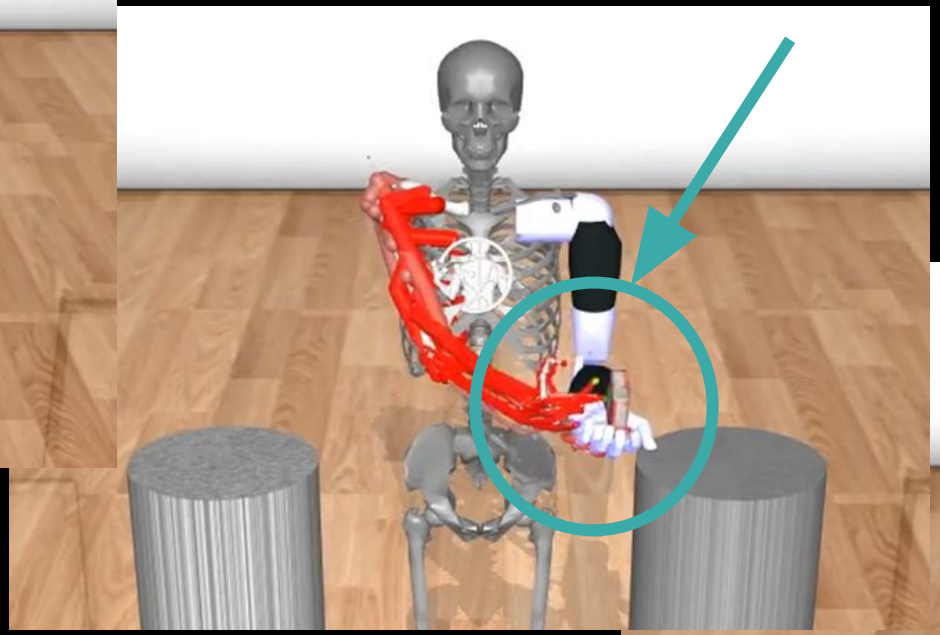


Evaluation criteria – Manipulation

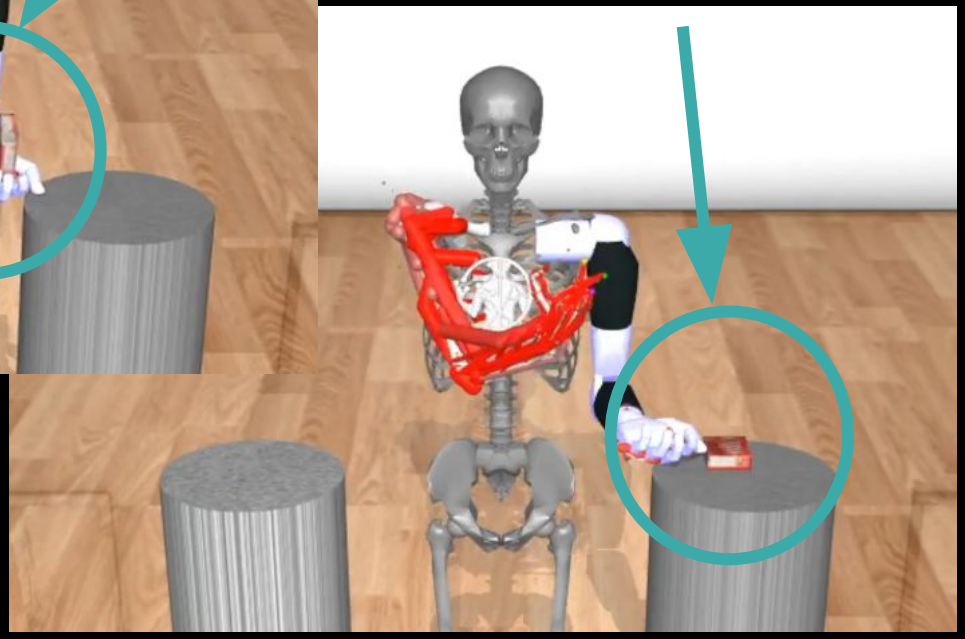


MyoArm Holding Object

MyoMPL Holding Object

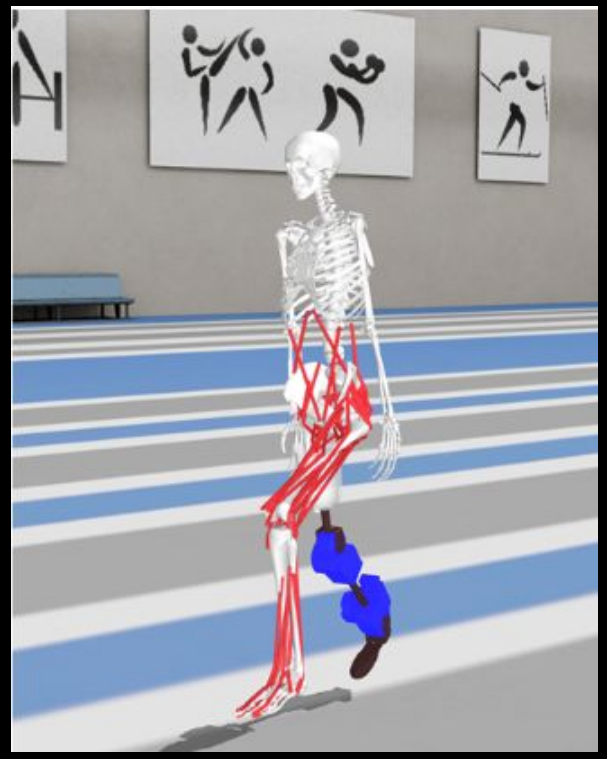


Final Placement



Primary: Fraction of successful episodes
Secondary: Overall muscular effort

Track 2 – Prosthesis Locomotion



MyoLeg (Amputated)

54 muscles

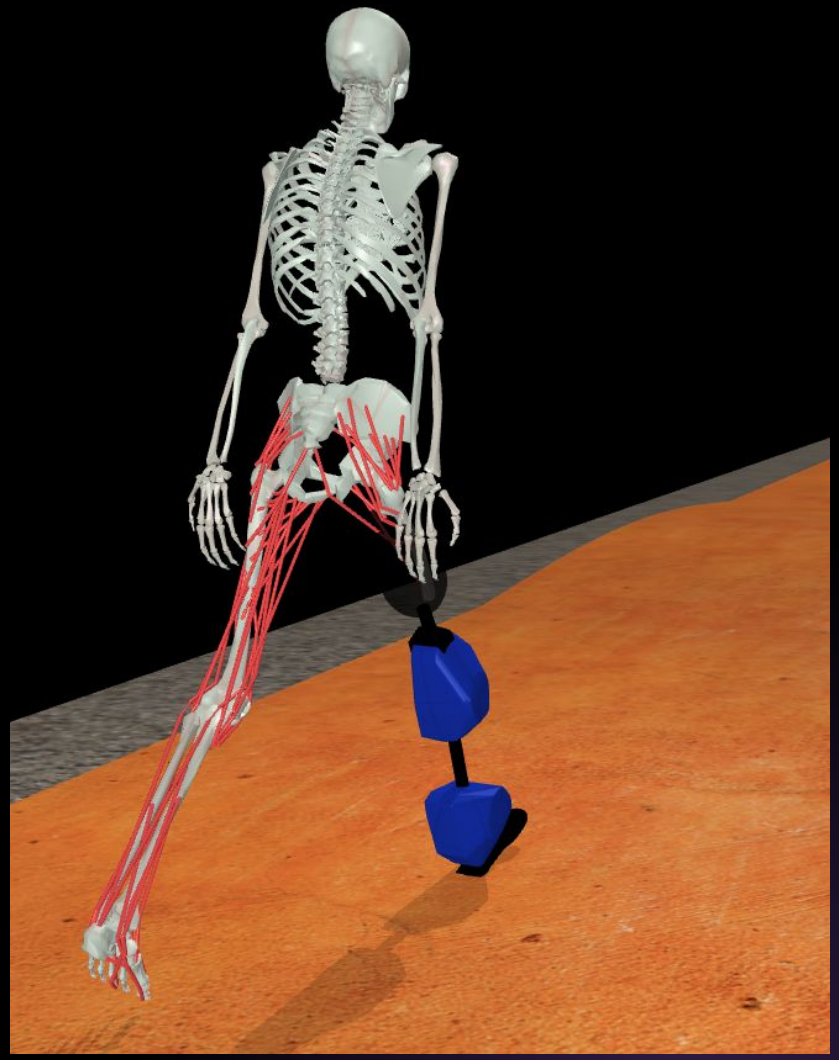
15 Degree of Freedom (DoF)

MyoOSL

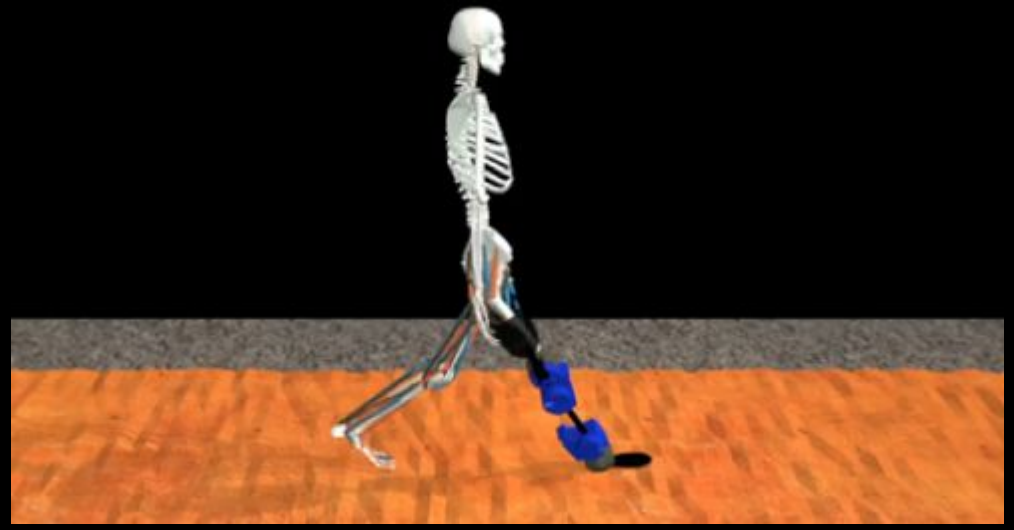
Finite-state machine, 2 actuators

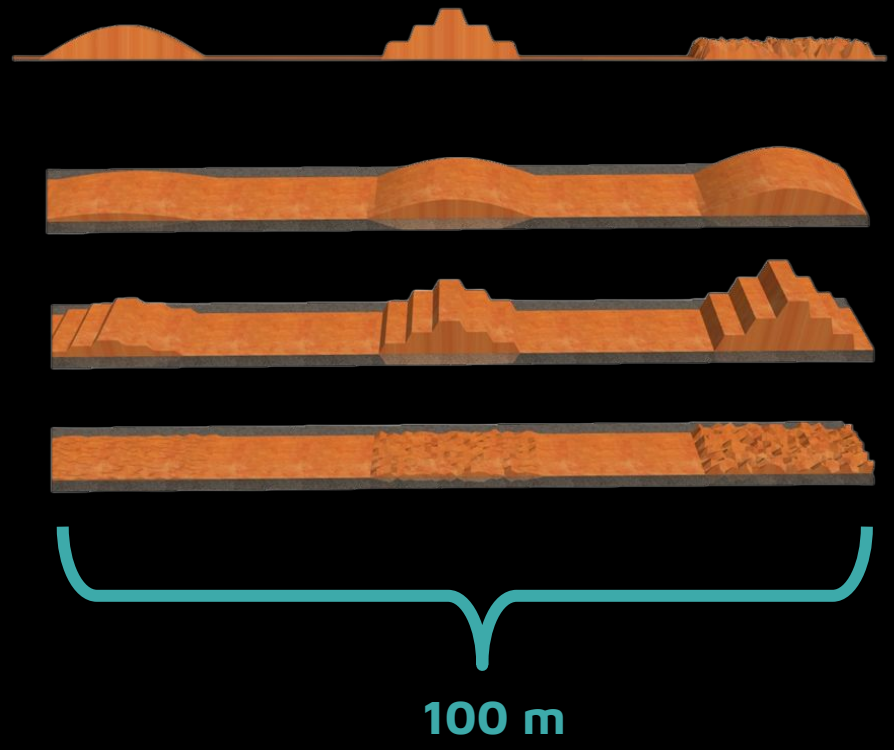
4 Degree of Freedom (DoF)

Based on the Open Source Leg
from the Neurobionics Lab



Evaluation criteria – Locomotion



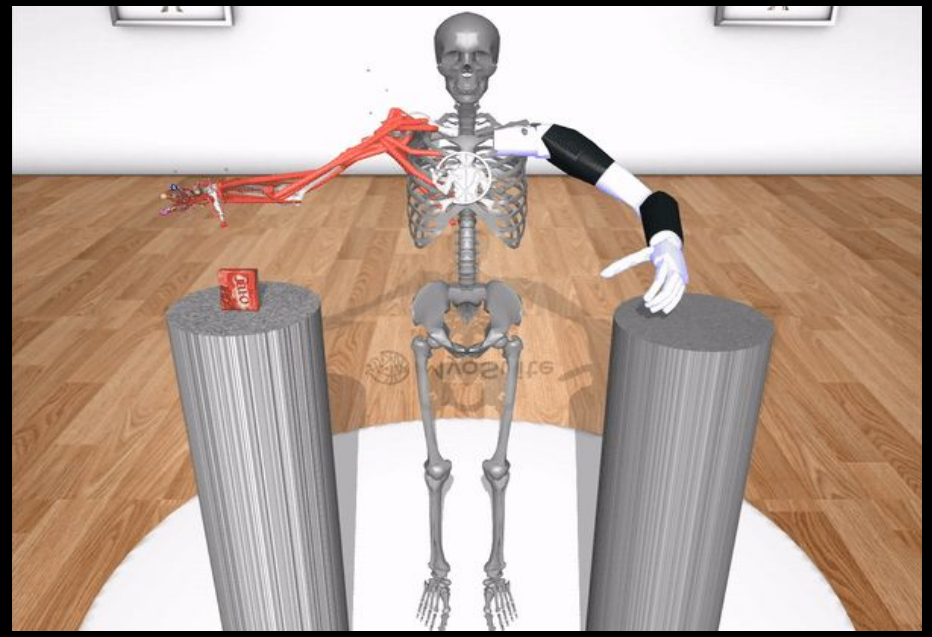


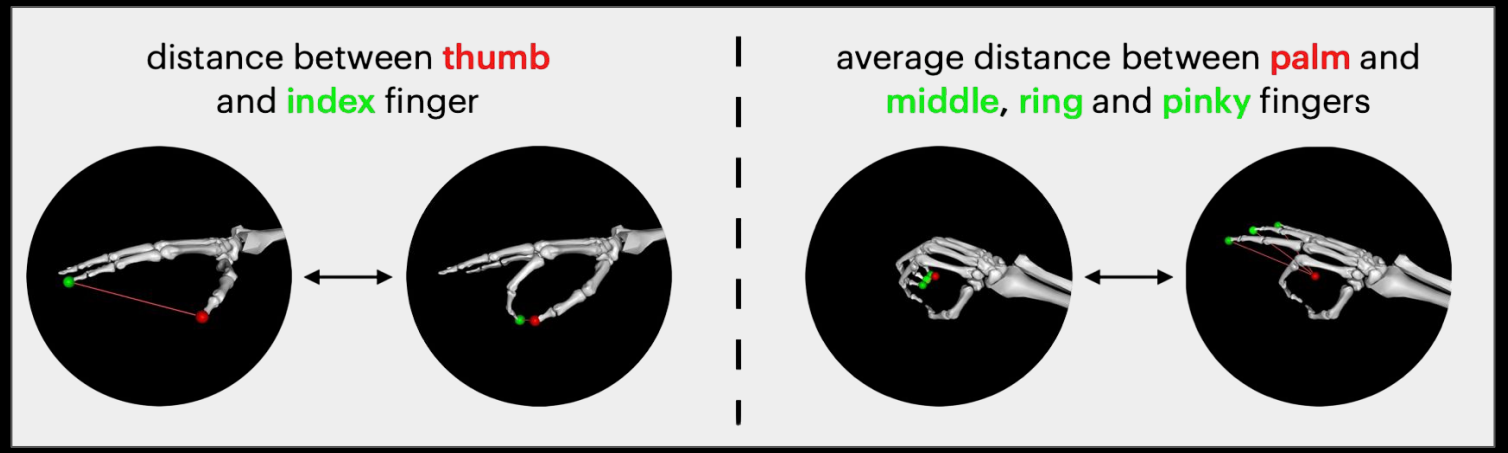
Primary: Averaged distance traveled
Secondary: Overall muscular effort

Muscle Synergy with Curriculum Learning

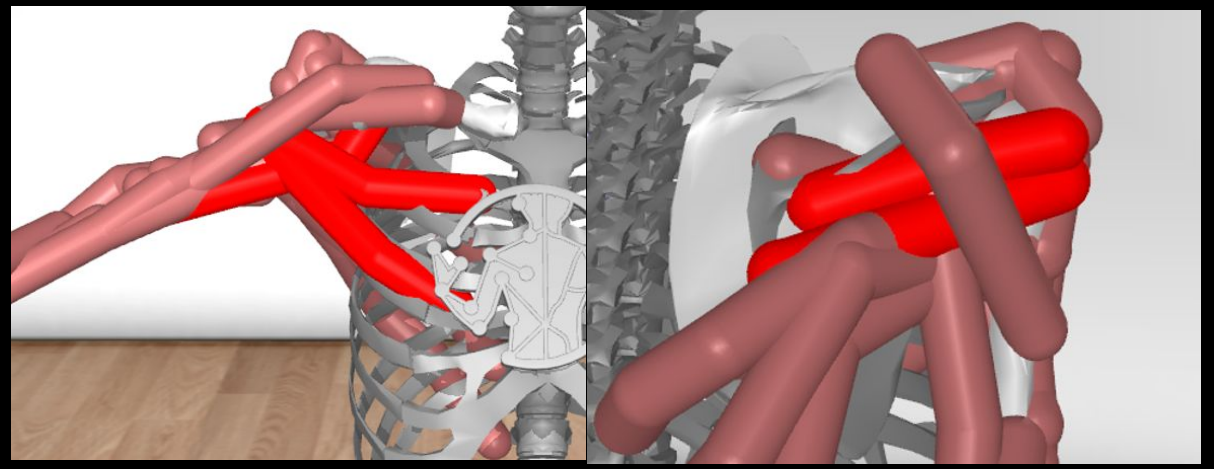
Synergy-based control of muscle activations overcomes dimensionality challenges, enabling natural and scalable movement in complex biomechanical systems.

Video from Winning Solution



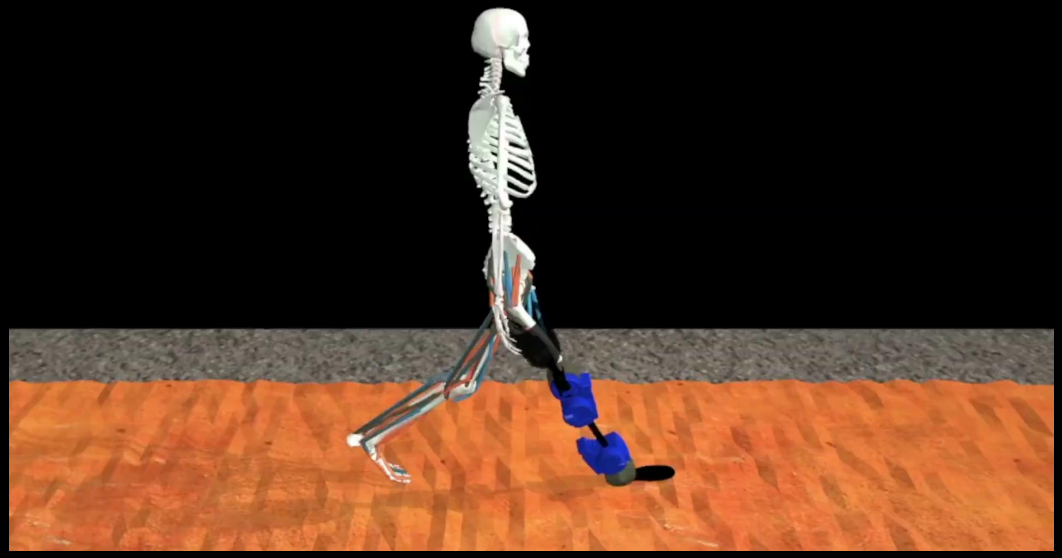


First place Winning Solution



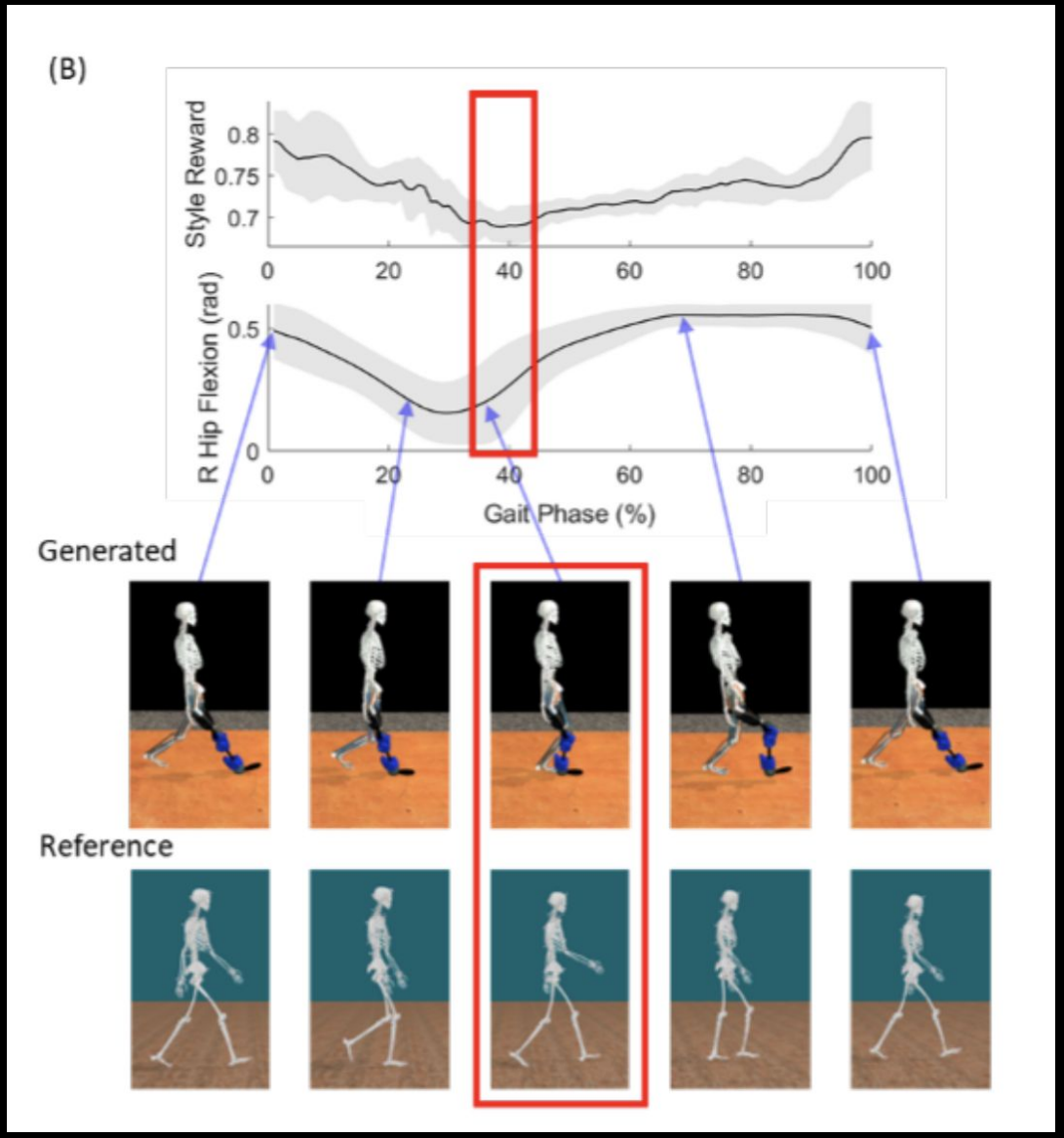
Second place Winning Solution

Motion Capture with Imitation Learning



Video from Winning Solution

Use of human motion data mitigates the search and credit-assignment challenges in high-dimensional control, removing the need for reward engineering and generalize to unseen terrains and tasks.



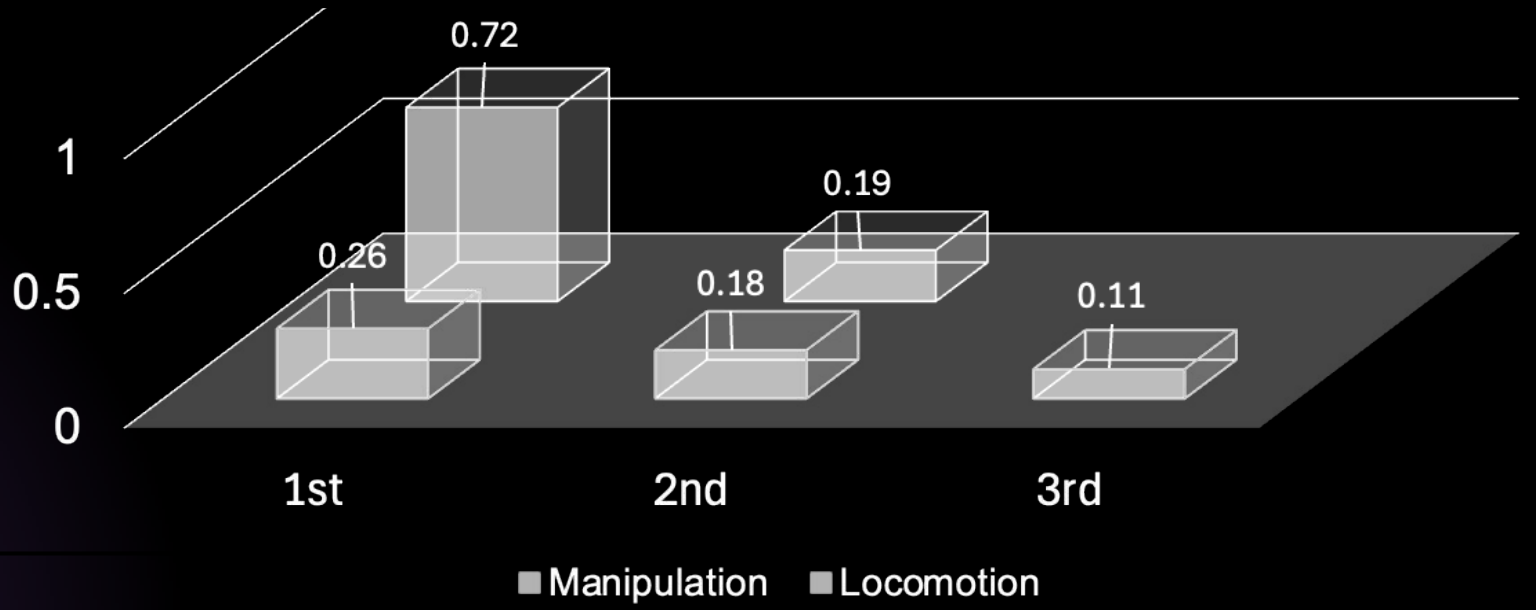
Competition Statistic and Impact

54

15+

292

14k



Contributions

- First open benchmark for coordinated control of biological + prosthetic limbs in realistic, muscle-driven simulation.
- Released new bionic models and tasks (myoMPL & myoOSL) and an open evaluation pipeline to advance human robot interaction research.
- Inspired solutions to solve human level motor and adaptability skills from worldwide community