Novelty Assessment Report

Paper: Musculoskeletal simulation of limb movement biomechanics in Drosophila melanogaster
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Abstract

Computational models are critical to advance our understanding of how neural, biomechanical, and physical systems interact to orchestrate animal behaviors. Despite the availability of near-complete reconstructions of the Drosophila melanogaster central nervous system, musculature, and exoskeleton, anatomically and physically grounded models of fly leg muscles are still missing. These models provide an indispensable bridge between motor neuron activity and joint movements. Here, we introduce the first 3D, data-driven musculoskeletal model of Drosophila legs, implemented in both OpenSim and MuJoCo simulation environments. Our model incorporates a Hill-type muscle representation based on high-resolution X-ray scans from multiple fixed specimens. We present a pipeline for constructing muscle models using morphological imaging data and for optimizing unknown muscle parameters specific to the fly. We then combine our musculoskeletal models with detailed 3D pose estimation data from behaving flies to achieve muscle-actuated behavioral replay in OpenSim. Simulations of muscle activity across diverse walking and grooming behaviors predict coordinated muscle synergies that can be tested experimentally. Furthermore, by training imitation learning policies in MuJoCo, we test the effect of different passive joint properties on learning speed and find that damping and stiffness facilitate learning. Overall, our model enables the investigation of motor control in an experimentally tractable model organism, providing insights into how biomechanics contribute to generation of complex limb movements. Moreover, our model can be used to control embodied artificial agents to generate naturalistic and compliant locomotion in simulated environments.

Core Task Landscape

This paper addresses: **Musculoskeletal Modeling of Limb Movement in Fruit Flies**

A total of **29 papers** were analyzed and organized into a taxonomy with **17 categories**.

Taxonomy Overview

The research landscape has been organized into the following main categories:
- **Neuromechanical Simulation Frameworks**
- **Leg Musculoskeletal Models**
- **Kinematic Analysis and Modeling**
- **Mechanosensory Biomechanics**
- **Proprioception and Motor Control**
- **Biomimetic Robotics**
- **Neuromechanical Control Principles**
- **Connectomics and Neural Circuits**
- **Methodological Advances**

Complete Taxonomy Tree

- Musculoskeletal Modeling of Limb Movement in Fruit Flies Survey Taxonomy
- Neuromechanical Simulation Frameworks
  - Whole-Body Neuromechanical Models (5 papers)
  - [1] NeuroMechFly, a neuromechanical model of adult Drosophila melanogaster (Shravan Tata Ramalingasetty, 2022) View paper
  - [5] NeuroMechFly v2: simulating embodied sensorimotor control in adult Drosophila (Sibo Wang-Chen, 2024) View paper
  - [9] Whole-body physics simulation of fruit fly locomotion (Roman Vaxenburg, 2025) View paper
  - [10] Whole-body simulation of realistic fruit fly locomotion with deep reinforcement learning (Roman Vaxenburg, 2024) View paper
  - [16] An integrative computational modeling approach for Drosophila motor control (Ozdil, 2025) View paper
  - General-Purpose Simulation Frameworks (1 papers)
  - [8] FARMS: framework for animal and robot modeling and simulation (Jonathan Arreguit, 2025) View paper
- Leg Musculoskeletal Models ★ (2 papers)
  - [0] Musculoskeletal simulation of limb movement biomechanics in Drosophila melanogaster (Anon et al., 2026) View paper
  - [23] Pembe Gizem OZDIL (Ramdya, 2025) View paper
- Kinematic Analysis and Modeling
  - Leg Joint Kinematics (3 papers)
  - [2] Decomposition of 3D joint kinematics of walking in Drosophila melanogaster (Haustein, 2023) View paper
  - [3] A leg model based on anatomical landmarks to study 3D joint kinematics of walking in Drosophila melanogaster (Alexander, 2024) View paper
  - [27] Kinematic analysis of rhythmic motion: the cases of human hand tremor and fly wingbeat. (Soma Chakraborty, 2017) View paper
  - Flight Kinematics (1 papers)
  - [17] Wing and body motion during flight initiation in Drosophila revealed by automated visual tracking (Ebraheem I. Fontaine, 2009) View paper

- Mechanosensory Biomechanics
  - Campaniform Sensilla Mechanics (2 papers)
  - [7] A parametric finite element model of leg campaniform sensilla in Drosophila to study CS location and arrangement (Brian D. Saltin, 2023) View paper
  - [14] Ultra high-resolution biomechanics suggest that substructures within insect mechanosensors decisively affect their sensitivity (Gesa F. Dinges, 2022) View paper
  - Proprioceptor Feature Selectivity (2 papers)
  - [4] Biomechanical origins of proprioceptor feature selectivity and topographic maps in the Drosophila leg (Akira Mamiya, 2023) View paper
  - [18] Origins of proprioceptor feature selectivity and topographic maps in the Drosophila leg (Akira Mamiya, 2022) View paper
- Proprioception and Motor Control
  - Proprioceptive Feedback in Locomotion (2 papers)
  - [19] Fast tuning of posture control by visual feedback underlies gaze stabilization in walking Drosophila (Tomás L. Cruz, 2021) View paper
  - [22] Recovery of locomotion after injury in Drosophila melanogaster depends on proprioception (Alexander Isakov, 2016) View paper
  - Passive Muscle Forces (1 papers)
  - [20] Passive muscle forces in Drosophila are large but insufficient to support a fly's weight (Ninghan Wang, 2025) View paper
- Biomimetic Robotics
  - Hexapod Robot Platforms (3 papers)
  - [12] Neurodynamic modeling of the fruit fly Drosophila melanogaster (Clarus Goldsmith, 2020) View paper
  - [13] A biomimetic fruit fly robot for studying the neuromechanics of legged locomotion (Moritz Haustein, 2024) View paper
  - [24] Drosophibot: A fruit fly inspired bio-robot (C. Goldsmith, 2019) View paper
  - Robot Design Frameworks (1 papers)
  - [21] A framework for biomimetic robot design applied to the development of a robotic model of Drosophila melanogaster (Clarissa A Goldsmith, 2025) View paper
- Neuromechanical Control Principles
  - Flight Control and Aerodynamics (2 papers)
  - [25] Closing the loop between neurobiology and flight behavior in Drosophila (Mark A. Frye, 2004) View paper
  - [26] Body appendages fine-tune posture and moments in freely manoeuvring fruit flies (Ruben Berthé, 2015) View paper
  - Muscle Stiffness Control (1 papers)
  - [28] Slow Limb Movements Require Precise Control of Muscle Stiffness (Sarine Babikian, 2015) View paper
  - Developmental and Comparative Neuromechanics (1 papers)
  - [15] A single microRNA-Hox gene module controls equivalent movements in biomechanically distinct forms of Drosophila (A. Raouf Issa, 2019) View paper
- Connectomics and Neural Circuits (1 papers)
  - [6] Connectomic reconstruction of a female Drosophila ventral nerve cord (Anthony Azevedo, 2024) View paper
- Methodological Advances
  - Soft-Bodied Locomotion Biomechanics (1 papers)
  - [11] The development and use of elastic resonators to study biomechanics in soft-bodied locomotion (Booth, 2024) View paper
  - Biomimetic Approaches (1 papers)
  - [29] Biomimetic approaches to new robotics (Dario, 1997) View paper

Narrative

Core task: musculoskeletal modeling of limb movement in fruit flies. This field integrates biomechanics, neuroscience, and computational modeling to understand how Drosophila generate and control leg movements. The taxonomy reveals a multifaceted landscape organized around several complementary themes. Neuromechanical Simulation Frameworks provide computational platforms that couple neural control with physical dynamics, exemplified by tools like NeuroMechFly[1] and its successor NeuroMechFly v2[5]. Leg Musculoskeletal Models focus on detailed anatomical representations of limb structure, muscle arrangements, and joint mechanics, as seen in Drosophila Leg Model[3]. Kinematic Analysis and Modeling emphasizes motion capture and quantitative descriptions of limb trajectories, while Mechanosensory Biomechanics and Proprioception and Motor Control branches explore how sensory feedback from campaniform sensilla and proprioceptors shapes movement. Biomimetic Robotics translates biological insights into engineered systems, and Connectomics and Neural Circuits leverage large-scale neural wiring diagrams such as the Drosophila Connectome[6] to inform control architectures. Methodological Advances capture cross-cutting technical innovations in imaging, simulation, and data analysis.

Within this landscape, a particularly active line of work centers on building increasingly realistic leg models that integrate muscle geometry, passive forces, and sensory feedback. Drosophila Limb Simulation[0] sits squarely in the Leg Musculoskeletal Models branch, emphasizing detailed anatomical fidelity and biomechanical accuracy. It shares this focus with Drosophila Leg Model[3], which similarly prioritizes muscle-tendon arrangements and joint kinematics, though the two may differ in their treatment of passive tissue properties or sensory integration. Meanwhile, works like NeuroMechFly[1] and NeuroMechFly v2[5] adopt a broader neuromechanical perspective, embedding leg models within whole-body simulations that couple neural circuits to physical dynamics. A key open question across these branches is how to balance anatomical detail with computational tractability, and how to validate models against behavioral data when proprioceptive feedback and neural control remain incompletely understood.

Related Works in Same Category

The following **1 sibling papers** share the same taxonomy leaf node with the original paper:

1. Pembe Gizem OZDIL

Authors: UP Ramdya | **Year/Venue**: 2025 | **URL**: View paper

Abstract

â¦ The musculoskeletal system of Drosophila legs is remarkably intricate. Each leg has approxâ¦ (C) Real limb kinematics were used to constrain the evolutionary optimization of â¦

⚠ Similarity Notice

This appears to be a PhD thesis by Pembe Gizem Ozdil that likely contains or is based on the original paper's work on musculoskeletal modeling of Drosophila limb movement. The thesis title 'An integrative computational modeling approach for Drosophila motor control' and the presence of Prof. P. P. Ramdya as thesis director strongly suggest this is the same research presented in dissertation format rather than a distinct independent work.

Contributions Analysis

Overall novelty summary. The paper presents a 3D, data-driven musculoskeletal model of Drosophila legs incorporating Hill-type muscle representations derived from high-resolution X-ray scans. It resides in the 'Leg Musculoskeletal Models' leaf, which contains only two papers total. This is a notably sparse research direction within the broader taxonomy, suggesting that anatomically detailed leg models remain an underexplored area despite the availability of connectome and morphological data. The sibling paper in this leaf shares the focus on muscle-tendon-skeleton systems for simulating limb biomechanics.

The taxonomy reveals that neighboring work divides into two main streams: whole-body neuromechanical frameworks (five papers) that integrate neural control with musculoskeletal dynamics across walking and flight, and kinematic analysis methods (four papers) that focus on joint angles and motion capture without muscle force modeling. The paper's emphasis on anatomical detail and muscle-actuated replay positions it between these streams—more mechanistic than pure kinematics, yet more limb-focused than whole-body neuromechanical platforms. The exclude_note for this leaf explicitly distinguishes it from neural integration frameworks and kinematic-only approaches.

Among 26 candidates examined, each of the three contributions shows at least one potentially overlapping prior work. The first contribution (3D musculoskeletal model) examined six candidates with one refutable match; the pipeline for constructing muscle models examined ten candidates with one refutable; and the behavioral replay contribution examined ten candidates with one refutable. These statistics indicate that within the limited search scope, each major claim encounters some degree of prior overlap, though the majority of examined candidates (23 of 26 total) do not clearly refute the contributions. The search scale is modest, leaving open the possibility of additional relevant work beyond the top-K semantic matches.

Based on the limited literature search, the work appears to occupy a relatively sparse research niche—detailed leg musculoskeletal modeling—while each contribution shows partial overlap with at least one prior candidate. The taxonomy structure confirms that this specific combination of anatomical detail, muscle modeling, and behavioral replay is less crowded than adjacent areas like whole-body neuromechanical simulation. However, the modest search scope (26 candidates) and the presence of refutable matches for all three contributions suggest that claims of absolute novelty should be tempered by acknowledgment of existing foundational work in this domain.

This paper presents **3 main contributions**, each analyzed against relevant prior work:

Contribution 1: First 3D data-driven musculoskeletal model of Drosophila legs

Description: The authors develop the first anatomically and physically grounded musculoskeletal model of Drosophila melanogaster legs incorporating Hill-type muscle representations based on high-resolution X-ray scans. The model is implemented in two widely used physics engines (OpenSim and MuJoCo) and includes 15 muscle-tendon units per foreleg actuating seven degrees of freedom across three leg joints.

This contribution was assessed against **6 related papers** from the literature. Papers with potential prior art are analyzed in detail with textual evidence; others receive brief assessments.

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1. Kinematic modeling at the ant scale: propagation of model parameter uncertainties
URL: View paper

Brief Assessment

Ant Kinematic Modeling[41] focuses on kinematic modeling of Messor barbarus ants using multibody models without muscle representations, whereas the original paper develops Hill-type muscle models for Drosophila with explicit muscle-tendon units and force generation capabilities.

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2. A neuro-musculo-skeletal model for insects with data-driven optimization
URL: View paper

Brief Assessment

Insect Neuromusculoskeletal Model[40] focuses on ants (Cataglyphis fortis) with a different modeling approach using spiking neurons and evolutionary optimization, not Drosophila melanogaster with Hill-type muscles optimized via NSGA-II as in the original paper.

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3. Muscle coordination during load carrying at the ant scale: an OpenSim simulation based on Messor barbarus
URL: View paper

Brief Assessment

Ant Load Carrying[42] focuses on musculoskeletal modeling of Messor barbarus ants using OpenSim, not Drosophila. The candidate models ant thoracic muscles for load carrying behavior, while the original develops the first comprehensive Drosophila leg muscle model with Hill-type representations across multiple joints and behaviors.

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4. Dynamics and stability of insect locomotion: a hexapedal model for horizontal plane motions
URL: View paper

Brief Assessment

Hexapedal Locomotion Dynamics[43] focuses on horizontal plane dynamics using simplified spring-based leg models without anatomically detailed musculoskeletal structures. The candidate does not address 3D musculoskeletal modeling with Hill-type muscles based on X-ray scans.

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5. NeuroMechFly, a neuromechanical model of adult Drosophila melanogaster
URL: View paper

Prior Art Analysis

NeuroMechFly[1] demonstrates that a 3D data-driven musculoskeletal model of Drosophila melanogaster incorporating muscle models in physics-based simulation environments was published prior to the original paper. Both papers develop computational models of adult Drosophila that combine anatomical data with muscle representations in simulation frameworks. NeuroMechFly[1] explicitly states it presents a 'data-driven computational model' that 'combines a set of modules including an exoskeleton with articulating body parts--- limbs' and 'muscle models' within 'a physics-based simulation environment.' This directly overlaps with the original paper's claim of being 'the first 3d, data-driven musculoskeletal model of drosophila legs' implemented in physics engines.

Evidence

Evidence 1 - **Rationale**: Both papers claim to present data-driven musculoskeletal models of Drosophila melanogaster that incorporate muscle models within physics-based simulation environments. NeuroMechFly[1] explicitly includes limbs with muscle models, directly challenging the original paper's claim of being 'the first' such model. - **Original**: here, we introduce the first 3d, data-driven musculoskeletal model of drosophilalegs, implemented in both opensim and mujoco simulation environments. our model incorporates a hill-type muscle representation based on highresolution x-ray scans from multiple fixed specimens. - **Candidate**: here we present neuromechfly, a data-driven computational model of the adult female fly that is designed to synthesize rapidly growing experimental

datasets and to test theories of neuromechanical behavioral control. neuromechfly combines a set of modules including an exoskeleton with articulating b...

Evidence 2 - **Rationale**: NeuroMechFly[1] presents itself as the first simulation framework for Drosophila melanogaster that combines neuromechanical elements, which would include musculoskeletal modeling of the organism prior to the original paper's submission. - **Original**: the fruit fly,drosophila melanogaster, represents an ideal organism for this reverse-engineering challenge. flies generate complex behaviors using a compact, well-characterized, and genetically - **Candidate**: until now, there has been no such simulation framework for the widely studied model organism, drosophila melanogaster. here we present neuromechfly, a data-driven computational model of the adult female fly that is designed to synthesize rapidly growing experimental datasets and to test theories of ...

Evidence 3 - **Rationale**: The original paper itself acknowledges NeuroMechFly as 'the first anatomically realistic fly body model' that used CT scans for 3D simulation, which directly contradicts the claim of being the first 3D data-driven musculoskeletal model of Drosophila legs. - **Original**: recently, the fruit fly,drosophila melanogaster, has become an increasingly prominent animal model for musculoskeletal simulations. the first anatomically realistic fly body model, neuromechfly, used micro-computed tomography (micro-ct) scans to construct a morphologically accurate 3d fly simulation... - **Candidate**: neuromechfly combines a set of modules including an exoskeleton with articulating body parts---limbs, halteres, wings, abdominal segments, head, proboscis, and antennae---muscle models, and neural networks within a physics-based simulation environment.

6. NeuroMechFly v2: simulating embodied sensorimotor control in adult Drosophila
URL: View paper

Brief Assessment

NeuroMechFly v2[5] focuses on sensorimotor control with vision, olfaction, and hierarchical controllers, not on developing detailed musculoskeletal models with Hill-type muscle representations based on X-ray scans.

Contribution 2: Pipeline for constructing muscle models from morphological imaging data

Description: The authors introduce an end-to-end automated pipeline that extracts anatomical features from imaging data, estimates physiological parameters, and optimizes unknown parameters using multi-objective optimization to match behavioral kinematics. This framework links anatomical inputs to functional muscle-driven simulations.

This contribution was assessed against **10 related papers** from the literature. Papers with potential prior art are analyzed in detail with textual evidence; others receive brief assessments.

1. Automated high-content morphological analysis of muscle fiber histology
URL: View paper

Brief Assessment

Muscle Fiber Analysis[39] focuses on automated morphological analysis of muscle fiber histology for feature extraction, not on constructing functional musculoskeletal models with physiological parameter optimization for behavioral simulation.

2. Optimizing the surface structural and morphological properties of silk thin films via ultra-short laser texturing for creation of muscle cell matrix model
URL: View paper

Brief Assessment

Laser Textured Silk[34] focuses on creating 2D porous silk scaffolds via laser microstructuring for muscle tissue engineering applications, not on computational pipelines for extracting anatomical features from imaging data or optimizing physiological parameters for muscle-driven simulations.

3. 3-D Ultrasonographic Quantification of Hand and Calf Muscle Volume: Statistical Shape Modeling Approach
URL: View paper

Brief Assessment

Ultrasound Muscle Volume[37] focuses on 3D ultrasonographic quantification and statistical shape modeling of hand and calf muscles, not on constructing functional muscle models with parameter optimization for behavioral simulations.

4. The songbird syrinx morphome: a three-dimensional, high-resolution, interactive morphological map of the zebra finch vocal organ
URL: View paper

Brief Assessment

Syrinx Morphome[35] focuses on creating a 3D morphological atlas of the zebra finch vocal organ using imaging techniques, not on constructing computational muscle models with parameter optimization for behavioral simulation as in the original paper.

5. Automated creation and tuning of personalised muscle paths for OpenSim musculoskeletal models of the knee joint
URL: View paper

Brief Assessment

Knee Muscle Paths[33] focuses on automated creation of muscle paths for OpenSim knee joint models using population-based morphing and optimization. The original paper presents a pipeline for Drosophila leg muscles using anatomical data extraction and multi-objective optimization to match behavioral kinematics, which is a fundamentally different application domain and methodology.

6. Three-dimensional realisation of muscle morphology and architecture using ultrasound
URL: View paper

Brief Assessment

Ultrasound Muscle Architecture[38] focuses on 3D visualization and morphological representation of muscle architecture using ultrasound imaging, not on constructing functional muscle-driven simulation pipelines with parameter optimization for behavioral kinematics.

7. A novel biomechanical model of the proximal mouse forelimb predicts muscle activity in optimal control simulations of reaching movements
URL: View paper

Prior Art Analysis

Mouse Forelimb Model[30] demonstrates that a similar end-to-end pipeline for constructing muscle models from imaging data with parameter optimization was developed prior to the original paper. Both papers describe extracting anatomical features from high-resolution imaging (X-ray/CT scans), estimating physiological parameters, and optimizing unknown parameters to match behavioral

kinematics. The candidate paper explicitly states they developed a musculoskeletal model based on high-resolution imaging that estimates muscle activity when constrained to tracked kinematics, which directly parallels the original paper's claimed novel pipeline.

Evidence

Evidence 1 - **Rationale**: Both papers describe developing musculoskeletal models from high-resolution imaging data with optimization to match behavioral kinematics, demonstrating that the pipeline approach was not novel to the original paper. - **Original**: here, we introduce the first 3d, data-driven musculoskeletal model of drosophilalegs, implemented in both opensim and mujoco simulation environments. our model incorporates a hill-type muscle representation based on highresolution x-ray scans from multiple fixed specimens. we present a pipeline for ... - **Candidate**: here, we developed a musculoskeletal model based on high-resolution imaging of the mouse forelimb that includes muscles spanning the neck, trunk, shoulder, and limbs. physics-based optimal control simulations of the forelimb model were used to estimate in vivo muscle activity present when constraine...

Evidence 2 - **Rationale**: Both papers implement their muscle modeling pipelines in OpenSim and use them to analyze behavioral data, showing that the framework linking anatomical inputs to functional simulations existed prior to the original work. - **Original**: we present a pipeline for constructing muscle models using morphological imaging data and for optimizing unknown muscle parameters specific to the fly. we then combine our musculoskeletal models with detailed 3d pose estimation data from behaving flies to achieve muscle-actuated behavioral replay in... - **Candidate**: our computational tools are available as open-source in the opensim physics and modeling platform. our model can enhance research into limb control across broad research topics and can inform analyses of motor learning, muscle synergies, neural patterning, and behavioral research that would otherwis...

8. Skeletal muscle segmentation from MRI dataset using a model-based approach
URL: View paper

Brief Assessment

Muscle Segmentation MRI[36] focuses on segmenting skeletal muscles from MRI for volume estimation using image processing and contour optimization. The original paper presents a neuromechanical pipeline that constructs Hill-type muscle models with physiological parameters optimized to match behavioral kinematics, which is a fundamentally different approach and application domain.

9. Investigation of the dependence of joint contact forces on musculotendon parameters using a codified workflow for image-based modelling
URL: View paper

Brief Assessment

Joint Contact Forces[32] focuses on subject-specific musculoskeletal models of the human lower limb for clinical applications, not on automated pipelines for constructing muscle models from imaging data with multi-objective parameter optimization as described in the original paper.

10. Optimized uniform sampling and validation of fiber tracts from magnetic resonance tractography for in vivo architectural measurement of human forearm muscles
URL: View paper

Brief Assessment

Fiber Tract Sampling[31] focuses on sampling and validating fiber tracts from MR tractography for architectural measurement, not on constructing complete muscle models with parameter optimization for functional simulations.

Contribution 3: Muscle-actuated behavioral replay combining musculoskeletal models with 3D pose estimation

Description: The authors integrate their musculoskeletal model with detailed 3D pose estimation data from behaving flies to reproduce muscle-driven movements in simulation. This enables prediction of coordinated muscle synergies across diverse behaviors like walking and grooming that can be experimentally tested.

This contribution was assessed against **10 related papers** from the literature. Papers with potential prior art are analyzed in detail with textual evidence; others receive brief assessments.

1. Virtual reality skateboarding training for balance and functional performance in degenerative lumbar spine disease
URL: View paper

Brief Assessment

VR Skateboarding Training[53] focuses on virtual reality rehabilitation for degenerative lumbar spine disease patients, not on muscle-actuated behavioral replay or integration of musculoskeletal models with 3D pose estimation for predicting coordinated muscle synergies.

2. Biomechanical gait analysis using a smartphone-based motion capture system (opencap) in patients with neurological disorders
URL: View paper

Brief Assessment

Smartphone Gait Analysis[51] focuses on clinical gait assessment in neurological patients using smartphone-based motion capture, not on muscle-actuated behavioral replay or prediction of muscle synergies from 3D pose data.

3. A subject-specific musculoskeletal model to predict the tibiofemoral contact forces during daily living activities
URL: View paper

Brief Assessment

Tibiofemoral Contact Forces[52] focuses on predicting knee joint contact forces during human daily activities using subject-specific musculoskeletal models, not on muscle-actuated behavioral replay combining musculoskeletal models with 3D pose estimation for reproducing coordinated muscle synergies across diverse behaviors in flies.

4. Predicting kinetics using musculoskeletal modeling and inertial motion capture
URL: View paper

Brief Assessment

Inertial Motion Capture[45] focuses on predicting kinetics using musculoskeletal modeling with inertial motion capture for human gait analysis, not on muscle-actuated behavioral replay in Drosophila combining detailed 3D pose estimation with muscle synergy prediction.

5. The impact of neck pain and movement performance on the interarticular compressive force of the cervical spine: a cross-sectional study based on OpenSim
URL: View paper

Brief Assessment

Neck Pain Compressive[47] focuses on cervical spine biomechanics in neck pain patients using OpenSim for joint reaction analysis, not on muscle-actuated behavioral replay or 3D pose estimation for movement reproduction.

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6. Peak tibiofemoral contact forces estimated using IMU-based approaches are not significantly different from motion capture-based estimations in patients with â⌁¦
URL: View paper

Brief Assessment

IMU Tibiofemoral Forces[50] focuses on validating IMU-based force estimation against motion capture in clinical knee biomechanics, not on muscle-actuated behavioral replay or integrating musculoskeletal models with 3D pose estimation for predicting coordinated muscle synergies.

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7. Bioengineering Support in the Assessment and Rehabilitation of Low Back Pain
URL: View paper

Brief Assessment

Low Back Pain[48] focuses on bioengineering tools for clinical assessment and rehabilitation of low back pain in humans, not on muscle-actuated behavioral replay or integration of musculoskeletal models with 3D pose estimation for simulating animal movements.

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8. Assessing the biomechanics of scheuermann's kyphosis affected thoracolumbar spine in forward flexion at the tissue-level using a finite element model
URL: View paper

Brief Assessment

Scheuermann Kyphosis Biomechanics[49] focuses on spinal biomechanics in kyphosis patients using musculoskeletal-FEM coupling, not on muscle-actuated behavioral replay or insect locomotion control as in the original paper.

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9. Physical based motion reconstruction from videos using musculoskeletal model
URL: View paper

Prior Art Analysis

Motion Reconstruction Videos[44] demonstrates that the integration of musculoskeletal models with 3D pose estimation for muscle-driven behavioral replay was already established prior to the original paper. The candidate paper explicitly describes combining human pose estimation with physical simulation to reconstruct motions in a physically simulated environment using a musculoskeletal system model. Both papers employ pose estimation to generate reference motion and then use this data to drive muscle-actuated simulations that reproduce the observed behaviors. The candidate's hierarchical control framework that minimizes differences between reference and simulated poses parallels the original paper's approach of combining musculoskeletal models with detailed 3D pose estimation data to achieve muscle-actuated behavioral replay.

Evidence

Evidence 1 - **Rationale**: Both papers describe combining musculoskeletal models with pose estimation data to reproduce behaviors in simulation. The candidate demonstrates this approach was already established for reconstructing motion from videos using musculoskeletal models. - **Original**: we then combine our musculoskeletal models with detailed 3d pose estimation data from behaving flies to achieve muscle-actuated behavioral replay in opensim. - **Candidate**: our approach allows characters to learn from the actor's skills captured in videos and subsequently reconstruct the motions with high fidelity in a physically simulated environment. firstly, we model the character based on the human musculoskeletal system and build a complete dynamics model of the p...

Evidence 2 - **Rationale**: Both papers use muscle-driven simulations to reproduce diverse behaviors. The candidate's muscle control layer that generates forces to match reference poses demonstrates the prior existence of muscle-actuated behavioral replay systems. - **Original**: simulations of muscle activity across diverse walking and grooming behaviors predict coordinated muscle synergies that can be tested experimentally. - **Candidate**: finally, we design a hierarchical control framework consisting of a trajectory tracking layer and a muscle control layer. the trajectory tracking layer aims to minimize the difference between the reference motion pose and the actual output pose, while the muscle control layer aims to minimize the di...

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10. Corroboration of coupled musculoskeletal model and finite element predictions with in vivo RSA migration of an uncemented acetabular component
URL: View paper

Brief Assessment

Acetabular Component Migration[46] focuses on validating finite element models of acetabular cup migration in hip replacement surgery using radiostereometric analysis. It does not address muscle-actuated behavioral replay, musculoskeletal modeling of limb movements, or 3D pose estimation for behavioral analysis.

Appendix: Text Similarity Detection

No high-similarity text segments were detected across any compared papers.

References

- [0] Musculoskeletal simulation of limb movement biomechanics in Drosophila melanogaster View paper
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- [40] A neuro-musculo-skeletal model for insects with data-driven optimization View paper
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