

Sriram Sekaripuram Muralidhar

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EDUCATION

The Ohio State University
PhD in Mechanical Engineering
Advisor: Dr. Manoj Srinivasan

August 2024
(expected)

National Institute of Technology, Karnataka, India
BTech in Mechanical Engineering

May 2019

TECHNICAL AND SOFTWARE SKILLS

Technical: Biomechanics data collection and analysis (motion capture systems, force plates, EMG, IMU, indirect calorimetry, real time feedback, and data acquisition systems), data-based modeling, optimization, inverse optimization and model parameter estimation, musculoskeletal modelling and simulation, hardware-in-the-loop optimization, machine learning, some computer vision and fabrication (3D printing).

Software: MATLAB (optimization, simulation, machine learning, etc.), Python (optimization, machine learning, simulation, etc.), Vicon Nexus (marker-based motion capture), OpenSim (biomechanical simulation), Arduino (microcontroller robot control), Mujoco (multibody simulation), OpenCV (computer vision)

RELEVANT COURSEWORK

Advance dynamics, Introduction to Musculoskeletal Biomechanics, Experimental methods in biomechanics, Advance human and animal movement, Real-time robotics, Autonomy in vehicles, Reinforcement learning, Machine learning, Seminar on NIH Grant Writing, Future academic scholars training 1 and 2.

RESEARCH PROJECTS

Biomechanics: Data-derived metabolic cost model for human force production

(completed)

- Previous metabolic cost models have assumed linear relations with force and have not so accurate prediction of metabolic cost for isometric tasks.
- We designed human metabolic experiments and fit simple power-law relations based on joint torque and torque rate for constant and time-varying isometric forces.
- We showed that the cost is nonlinear with the exponents being less than quadratic growth with respect to torque and faster than quadratic growth for torque rate. We also showed that the cost is higher for decreasing the force compared to increasing which is not considered in previous metabolic cost models.

Sensorimotor control: Bilateral force sharing (predictive modeling and experiments)

(completed)

- Force sharing between the limbs is a necessity to perform various physical activities and previous experimental studies have shown patterns in human behavior, yet we do not know the reason for such behavior.
- We performed new human upper and lower limb behavioral experiments in which humans had a choice regarding how they shared forces between different limbs. We showed human behavior is well-predicted by metabolic cost minimization, using our metabolic cost model.
- We provided mathematical support for muscle-level costs being governed by similar laws suggesting that muscle force sharing may be achieved by energy optimality.

Biomechanics and large-scale physics-based predictive models: Mechanics and control during yoga postures *(in progress)*

- Yoga poses are isometric and previous literature studying the musculoskeletal impact of yoga is limited to few postures and joints analyzed experimentally.
- We are developing a computational framework to predict joint torques of 57 yoga poses in 2D sagittal plane. The framework consists of extracting joint angles and contact points from images of yoga poses using manual digitization and performing predictive optimization calculations using a whole-body human model in MuJoCo with our metabolic cost model.
- This will result in a novel kinematics and kinetics dataset of yoga poses and a framework which can be used to predict joint torques for any sagittal plane posture.

Robot-in-the-loop optimization: Testing optimization algorithms on a hexapod robot to improve walking speed

- We developed a robot in the loop optimization pipeline using an open-source hexapod robot MiniRhex, optical motion capture and computer vision to estimate velocity and MATLAB to perform optimization calculation.
- Assessed the performance of gradient descent, random search and Bayesian optimization in estimating the phase coherence between the legs which yields maximum forward speed.

JOURNAL PUBLICATIONS

Sekaripuram Muralidhar, Sriram, Nadja Marin, Colin Melick, Aya Alwan, Zhengcan Wang, Ross Baldwin, Sam Walcott, and Manoj Srinivasan. Metabolic cost for isometric force scales nonlinearly and predicts human force sharing. In preparation for PNAS . [Pre-print available](#)

Sekaripuram Muralidhar, Sriram, Kristen Heitman, Sam Walcott, Manoj Srinivasan. Metabolic energy expenditure for time-varying isometric forces. In preparation for Proceedings of Royal Society B. [Pre-print available](#)

Sekaripuram Muralidhar, Sriram and Manoj Srinivasan. Biomechanical and control model for Yoga. (in preparation)

CONFERENCE PRESENTATIONS

S. S. Muralidhar, K. Heitmann, R. Baldwin, S. Walcott, M. Srinivasan. Metabolic cost model for time-varying isometric force contractions: cost to reduce force more than increasing. Annual Meeting of the American Society of Biomechanics, Madison, WI, 2024 (accepted).

S. S. Muralidhar, S. Walcott, M. Srinivasan. Human behavior is predicted well by minimizing effort but not signal-dependent noise. Conference on Dynamic Walking, Pensacola, FL, 2024.

S. S. Muralidhar, N. Marin, C. Melick, Z. Wang, A. Alwan, S. Walcott, M. Srinivasan. Metabolic Cost for Isometric Force Scales Nonlinearly with Force and Predicts Bilateral Limb Force Sharing. 5th Rocky Mountain Muscle Symposium, Canmore, 2023.

S. S. Muralidhar, N. Marin, Z. Wang, M. Srinivasan. Force sharing task with hands: An optimality framework from experiments. North American Congress on biomechanics, Ottawa, 2022.

S. S. Muralidhar, N. Marin, C. Melick, Z. Wang, A. Alwan, M. Srinivasan. Force Sharing: Cost Minimized by Humans is Correlated with Metabolic Cost of Force. Conference on Dynamic Walking, Madison, Wisconsin, 2022.

S. S. Muralidhar and M. Srinivasan. Learning in a robot. Virtual research week, Mechanical and Aerospace Engineering, Columbus, Ohio, 2020.

AWARDS

- Winner of 3 min thesis competition organized by the Department of Mechanical and Aerospace Engineering for the year 2022.

- Winner of \$500 travel grant to attend Dynamic Walking 2024.
- Departmental ambassador award of \$1000 for professional development and conference travel 2022-2023.

TEACHING EXPERIENCE

- Future Academic Scholars Training I (fall 2022): Semester-long course on teaching best practices and delivered two mock lectures covering an undergraduate course assessed by multiple faculty members.
- Teaching assistant for System dynamics and Vibrations (fall 2021): Creating example problems, conducting recitation lectures, and helping students during office hours.
- Grader for Statics (fall 2019): Grading assignment and quizzes.

PROPOSAL WRITING EXPERIENCE

- Seminar course on NIH grant writing (fall 2023): Semester-long course on proposal writing, requiring all students to complete a full NIH R21 proposal by the end of the course. I wrote a proposal on the Mechanics of Yoga, combining experiments, machine learning, and physics-based biomechanical modeling.
- Future Academic Scholars Training II (fall 2022): Semester-long course on different aspects of being a faculty member and required all students to write a one-page NSF project summary.
- Submitted a proposal to the Ohio State Alumni Grants for Graduate Research and Scholarship for International Research (fall 2023). Not funded.

PROFESSIONAL AND OUTREACH ACTIVITIES

Mechanical and Aerospace Engineering

Columbus, OH

Graduate Ambassador

August 2022- 2023

- Participated in incoming graduate student orientations, panel discussions and mentoring events.
- Collaborated with department staff in organizing research seminars, poster presentations and lab tours for incoming and potential students.
- Publicized about the department in university wide recruitment events.

Biomechanics interest group, The Ohio State University

Columbus, OH

Co-founder and convenor

August 2022- 2023

- Organized monthly meetings of biomechanics graduate students across all the departments at Ohio state. The meetings include lab tours, individual research presentations, professional development sessions or faculty presentations.

Biomechanics outreach, The Ohio State University

Columbus, OH

- Organized lab tours and seminar presentation on biomechanics for middle and high school students
- Organized school outreach during National Biomechanics Day by making videos on select topics in biomechanics, virtual panel discussions and in person lab tours.

OTHER EXPERIENCE

SPYSS international wing

Columbus, OH

Yoga instructor and volunteer

December 2020- Present

- Organized and conducted online yoga classes for USA and Canada residents in association with the non-profit organization Shri Pathanjali Yoga Shikshana Samithi. Currently leading the classes for college and high school students.

REFERENCES

Dr. Manoj Srinivasan
Associate Professor, Mechanical and Aerospace Engineering,
The Ohio State University.

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