

Margaret Eva W. Mungai

Ann Arbor, MI ♦ mungam@umich.edu ♦ www.evamungai.com

Interests

Control theory and experiments for robot locomotion and balancing, leveraging “risk tolerant” motions and the environment for recovery, and analyzing the stability and robustness of various optimal motions.

Skills

General: Robotics, Controls, Optimization, Modeling/Simulation, Technical Communication, Prototyping, Stability Analysis, Path Planning

Programming Experience: MATLAB, Python, C++

Tools: FROST, TensorFlow 2, PyTorch, Jiminy, CasADi, CORA, MuJoCo

Education

University of Michigan , Ann Arbor, MI	December 2023
<i>PhD in Mechanical Engineering</i>	(anticipated)
Rensselaer Polytechnic Institute , Troy, NY	May 2017
<i>Bachelor of Science in Mechanical Engineering</i>	

Research Experience

Bipedal Robotics Lab@Michigan, University of Michigan, Ann Arbor, MI
Research Assistant June 2017 - Present

- Fall Prediction Algorithm for the Digit Humanoid Robot:
 - Designed an algorithm capable of detecting abrupt, incipient, and intermittent faults in full-sized robots undertaking a standing task
 - Successfully implemented a fall prediction algorithm, both in simulation and on hardware
 - Developed a method for estimating lead time
- Fall Prediction Algorithm for Four Link Planar Bipedal Robot:
 - Designed an algorithm that maximizes lead time subject to bounds on false positive and negative rates
 - Introduced a method of identifying trajectories associated with incipient or abrupt faults
 - Developed a nearest-neighbor based fall detection algorithm that can detect both incipient and abrupt faults
- Sit-to-Stand Motion of an Exoskeleton:
 - Achieved two dynamic feedback stabilized user-friendly robust sit to stand motions for an exoskeleton + user system
 - Developed a novel way of systematically choosing virtual constraints for highly constrained systems
 - Designed two quadratic based Input/Output Control Linearization (aka Computed Torque) controllers to achieve the sit to stand motions
 - Analyzed the closed loop behavior of the sit-to-stand motions using physically motivated robustness tests

Center for Flow, Physics and Control, Rensselaer Polytechnic Institute, Troy, NY
Research Assistant Fall 2014 – Spring 2017

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- Participated in laminar separation bubble, Tollmein-Schlichting Waves, and stall cells research including data acquisition and analysis using software such as DaVis and Tecplot 360
- Designed (via NX 9), built and assembled experimental setups
 - Manufactured, and modeled a calibration mount for the laminar separation bubble
 - Developed the windows, motor assembly, and complete experimental model of the NACA 0015 airfoil for the lab's water tunnel to characterize stall cells.
 - Modified various experiment equipment and components utilizing a lathe and mill

Publications

Conferences

1. **M. E. Mungai** and J. Grizzle, "Fall Prediction for Bipedal Robots: The Standing Phase," arXiv preprint *arXiv:2309.14546* (2023), Submitted to ICRA 2024.
2. **M. E. Mungai** and J. Grizzle, "Optimizing Lead Time in Fall Detection for a Planar Bipedal Robot," 2023 3rd International Conference on Electrical, Computer, Communications and Mechatronics Engineering (ICECCME), Tenerife, Canary Islands, Spain, 2023, pp. 1-7, doi: 10.1109/ICECCME57830.2023.10253317.

Journals

1. **M. E. Mungai** and J. W. Grizzle, "Feedback Control Design for Robust Comfortable Sit-to-Stand Motions of 3D Lower-Limb Exoskeletons," in *IEEE Access*, vol. 9, pp. 122-161, 2021, doi: 10.1109/ACCESS.2020.3046446.
2. O. Harib, A. Hereid, A. Agrawal, T. Gurriet, S. Finet, G. Boeris, A. Duburcq, **M.E. Mungai**, M. Masselin, A. Ames, K. Sreenath, and J. Grizzle, "Feedback Control of an Exoskeleton for Paraplegics: Toward Robustly Stable, Hands-Free Dynamic Walking," in *IEEE Control Systems Magazine*, vol. 38, no. 6, pp. 61-87, Dec. 2018, doi: 10.1109/MCS.2018.2866604.
3. Shaylin Collins, **Margaret Eva Mungai** and Daisy Rojas, "E-Blox and Eclipse: Electronic Building Blocks and STEM Gaming Platform," in *The MANE Journal for Student Research, Innovation, and Design*, Vol. 2, 2017, https://mane.rpi.edu/sites/default/files/MANE_Journal_2017.pdf

Talks & Presentations

Michigan State University Educational Psychology and Educational Technology Brown Bag Speaker	November, 2022
Gordon Research Seminar Speaker	August, 2022
BDBA- Twin Cities Tech Talk	August, 2021
A Scientist Walks into a Bar Talk Show	May, 2021
NSBE Oral Presentation	March, 2020

Professional Experience

Wandercraft , Paris, France <i>Intern</i>	June – August 2018
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- Designed optimal, dynamically stable, comfortable, and assisted and unassisted sit-to-stand trajectories for various users—ranging from 54 kg and 1.62 m to 159 kg and 1.89 m— and the exoskeleton, Atalante
- Achieved the generated optimal sit-to-stand motions on the hardware, Atalante, with the appropriate users

Boeing Research and Technology, Tukwila, WA

Intern

June – August 2016

- Manufacturing Research and Development Engineer for the P-8 program
- Designed, prototyped (via fused deposition and metal laser sintering additive manufacturing), and manufactured shop aids to improve factory production, efficiency and safety while ensuring customer satisfaction
 - *Applied for a patent* for the Thermostat and Kiosk Monitoring System
 - Programmed and wired internals of a Raspberry Pi3 for “time and temperature sensitive material” cabinets

Boeing, Defense and Systems, Tukwila, WA

Intern

June – August 2015

- Tool Engineer for the P-8 program
- Developed new tools and improved existing designs to increase factory efficiency, productivity, and safety.
- Hired through the Engineering Accelerated Hiring Initiative (EAHI) program

Teaching and Mentoring Experience

Engineering Teaching Consultant, University of Michigan

Consultant

Fall 2022 (Ongoing)

- Responsibilities:
 - Lead practice teaching sessions for incoming graduate student instructors
 - Conduct midterm student feedback sessions and observe classes
 - Consult with graduate student instructors

Bipedal Robotics Lab@Michigan, University of Michigan

Research mentor

Summer – Fall 2020 and Winter 2023 (Ongoing)

Mentoring master’s students during their independent study in our lab

Rob 101 Computation Linear Algebra, University of Michigan

Graduate Student Instructor

Fall 2021

- Co-led the recitation section
- Taught the lab sections for the final project
- Rewrote the final project based on comments from previous students

Course Developer Team

Summer 2020

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- Co-developed the final project which introduced a simplified version of model predictive control to the students via a cart and segway

Course description: "Computational Linear Algebra is a first-semester, first-year undergraduate course that shows how mathematics and computation are unified for reasoning about data and making discoveries about the world."

Lunch & Lab with a Grad, University of Michigan

Mentor

Winter 2018

Mentored undergraduate students through the lunch and lab with a grad program

Relevant Coursework

Controls Theory	<ul style="list-style-type: none">• Linear Systems Theory• Linear Feedback Control Systems• Hybrid Control Systems• Nonlinear systems theory
Dynamics	<ul style="list-style-type: none">• Analytical and Computational Dynamics
Math	<ul style="list-style-type: none">• Advance Calculus I• Introduction to Topology• Mathematics for Robotics
Optimization	<ul style="list-style-type: none">• Model Predictive Control• Convex Optimization Methods in Control
Reasoning and Controls	<ul style="list-style-type: none">• Autonomous Robotics: Robot Modeling and Control
Signal Processing and Machine Learning	<ul style="list-style-type: none">• Probability and Random Processes• Machine Learning

Leadership & Activities

Legged League Locomotion

Co-chair, University of Michigan

Fall 2021 – Winter 2022

- An organization where graduate students and postdocs from various legged locomotion labs at the University of Michigan can discuss and share ideas.
- Co-founded the organization
- Organized seminar talks

Graduate Society of Black Engineers and Scientists (GSBES)

Communications Chair, University of Michigan

Fall 2018 – Spring 2019

MANE Student Advisory Council (SAC)

Chair, RPI

Fall 2016- Spring 2017

- Mechanical, Aeronautical, and Nuclear Engineering (MANE)
- *Founder and editor* of the MANE SAC Undergraduate Research and Design Journal
 - Departmental copyright in-house system
- Involved in faculty hiring, curriculum changes, and graduate seminars

Pi Tau Sigma

Vice President, RPI

Spring – Fall 2016

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- Mechanical Engineering Honor Society
- Spearheaded educational outreach program aimed at introducing the engineering design process to 5th and middle school students
 - Coordinated with the MANE department to receive funding
 - Pilot program launched fall 2016 at Sunnyside Center (Troy, NY)

MANE Student Advisory Council

Vice Chair for Faculty Hiring, RPI

2015-2016

National Society of Black Engineers (NSBE)

General body member

2013 – Present

Honors & Awards

Robotics Outreach Ambassador	2022
Robotics Institute Volunteer Award	2021
NSF Fellowship Recipient	2017
Rackham Merit Fellowship Recipient	2017
Low Family Scholarship Recipient	2016
Boeing Scholarship Recipient	2015
Rensselaer Ambassador at Scholarship Gala	2015
Pi Tau Sigma Member	2015