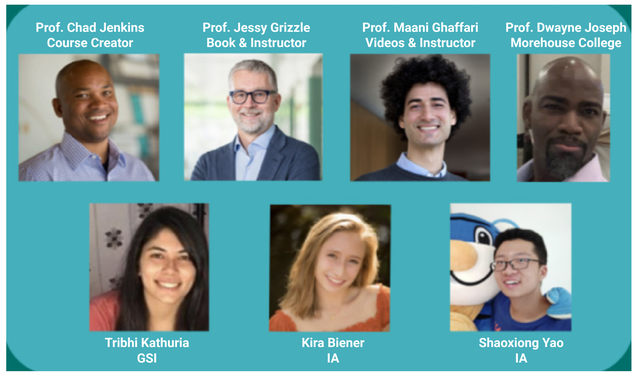
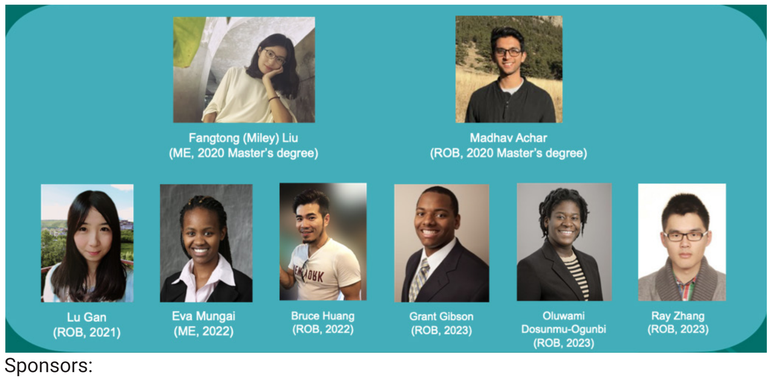
University of Michigan
Provost's Teaching Innovation Prize

2021 WINNER

ROBOTICS 101 Team Members, College of Engineering



ROBOTICS 101 Contributors



Sponsors:

Office of the Provost

Center for Research on Learning and Teaching (CRLT)

University Libraries

Breaking the AP Calculus Hold in STEM

Innovation Description

Many engineering curricula assume that students must have 3-4 semesters of calculus before they can begin solving realistic problems. This gives students from high schools with advanced placement programs a big head start for entering and succeeding in the discipline, while effectively shutting out students from non-AP high schools. Re-imagining the way mathematics is introduced to new engineering undergraduates provides a profound opportunity to level the playing field and enable students' success to be dictated by their intellectual ability and drive, not their zip codes.

ROBOTICS 101: *Computational Linear Algebra* is designed for equity from the ground up:

- Algebra is the only prerequisite, opening up engineering to everyone.
- Instead of assuming a programming background and access to high-end laptops and software, the course teaches students to program using Julia, an open-source language accessible through the Canvas web interface.
- Students build proficiency with lecture concepts through two types of homework: paper-and-pencil drill problems with a few variables and programming assignments at the scale of life, with hundreds of variables.
- Create distributed teaching collaboratives with minority serving institutions that expand pathways for students beyond COE's dual degree program with the Atlanta University Center Consortium.

The popularity of robotics draws in students from a wide range of backgrounds. Experiencing exciting applications right away and previewing how engineers actually use calculus motivates students to learn it. With confidence in their working knowledge of matrix mathematics and superior computation skills, students join amazing project teams during their first year and explore previously unconsidered paths to engineering careers.

Student Comments

I was so excited to be able to take a robotics course in my first semester. Math and science can often feel separate, but in ROB 101, we were literally applying math and seeing something manifest out of those calculations.

The weekly homework assignments helped me to see what the material we learned about in class allowed us to do, which was interesting.

The projects allowed us to apply our understanding of the material in real-world context with real data.

The best way to learn linear algebra if you don't love math and do love robotics/technology. It does a great job of teaching useful things and integrating the pure math with applied programming.

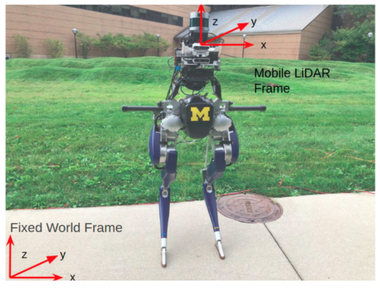
I am working on a docent robot for the U-M Museum of Art where I utilize the concepts learned in ROB 101 to design user input for the robot.

With greater experience in programming with Julia, I also confirmed that I want to take upper-level courses in computer science.

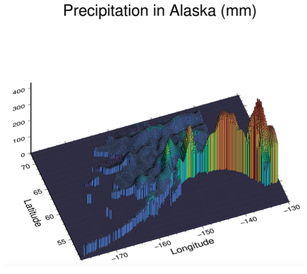
ROB 101 exposed me to technical topics I had previously not considered pursuing.

I appreciate that ROB 101 is making this kind of hands-on, applied learning experience available to first-year students.

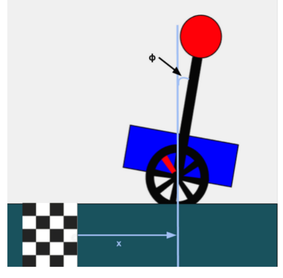
Examples of Teaching Innovation



The Cassie bipedal robot provided measurements for Project #1 Map Building from LiDAR Data.



Project #2 applies linear regression and machine learning methods to a large NOAA dataset.



Project #3 discusses least-squares optimization and Model Predictive Control in self-driving cars and Segways.