

Introduction

Prof. Nguyen's research span different control and optimization approaches for highly dynamic robotics. Within this project, we need to recreate the jumping controller on MIT Cheetah 3 robot, and implement it on A1 robot, a type of quadruped robot. Eventually, the goal is to make the robot jump and can do various motions, such as backflip, vertical jump, jump up and down a platform, jumping over obstacles.

These motions can be achieved by using trajectory optimization, jumping and landing controller.

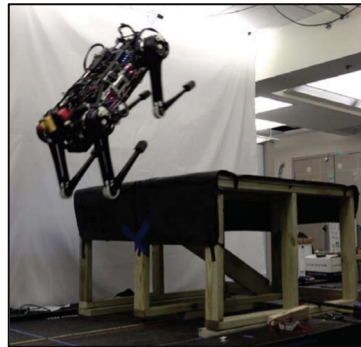


Fig. 1: MIT Cheetah 3 Robot jumps on the desk
PC: see citation [1]

Objective & Impact of Professor's Research

The objective of prof. Nguyen's research is to make the robot do multiple motions and behaviors. We can achieve this goal by simulate robot's motion in MATLAB and ROS. Then, we can implement the code into the real robot in order to make the robot behave as expected. With the ability to jump around, the robot can perform various tasks, which will make humans' daily lives more convenient. This approach is important and beneficial for humans because it can make humans' lives a lot more easier. For example, the robot can help people to do chores, carry loads, provide entertainment. More importantly, it can be used in large construction place. It can monitor process or investigate disaster. All in all, quadruped robot will bring social benefits to humans and give support

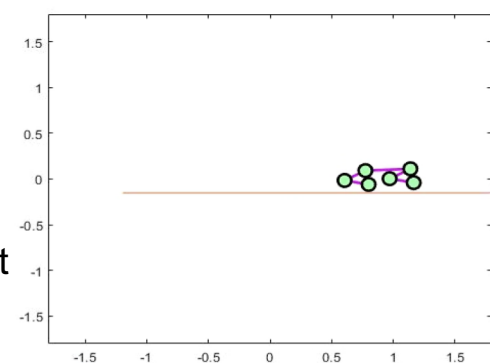


Fig. 2: MATLAB simulation of robot jumping 1 meter
PC: Coco Ma

Skills Learned

Through these seven weeks, I learned a lot of skills both on technical side and research side.

Technical:

- Install and operate Ubuntu
- Manipulate and analyze code in MATLAB
- Use commands that is specific to ROS in the terminal
- Basic physics about quadruped robot motion (vector, matrix, rigid body motion)
- PD controller and PID controller
- Manipulate variables on MATLAB to for differently desired motions
- Learn about QP control
- Understand the mechanics of jumping controller

Research:

- Find peer-reviewed articles that is related to current research
- Find other scholar articles based on several keywords
- Explicit and implicit rules in a lab
- How do researchers get their research funds
- What does a research pathway look like
- What are the values of individual researcher

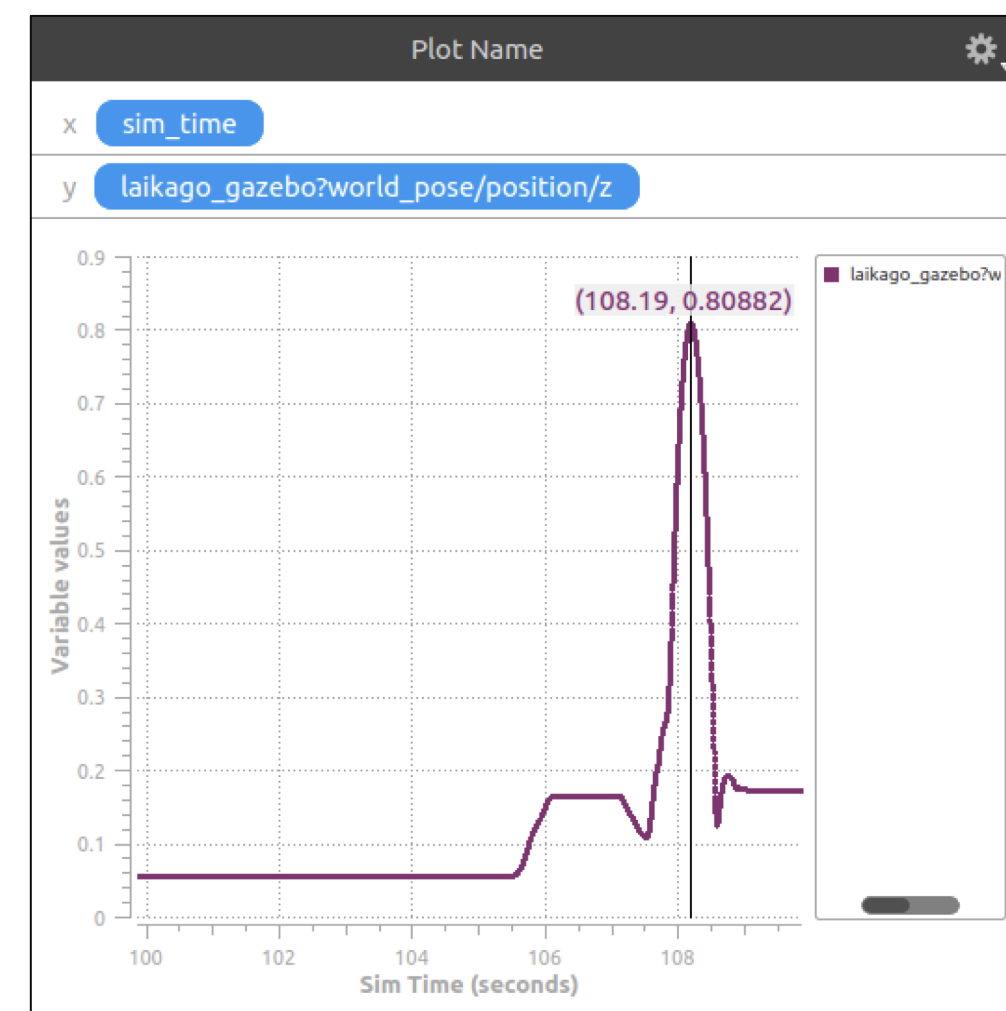


Fig. 3: Real-time graph of robot jumping highest in ROS PC: Coco Ma

How This Relates to Your STEM Coursework

I learned a lot of information that I've never learned in school throughout these seven weeks. I learned how research is conducted, and the process of a complete research. Also, I have experienced new things in my lab with my professor and my mentor. Through these processes, there are a lot of errors. And I need to fix it over and over again until the process is successful. The fixing process also teaches me a lot, because now I know how to fix these errors when they occur again. Sometimes you will experience new errors, and you will need to explore by yourself. In SHINE, I learned that difficulties are not always a bad thing. In the future, when I face problems in my STEM courses, I will not give up, and I will continue finishing my task. After attending this program, I have more determination in pursuing my STEM path.

Fig. 4: robot jump on a box or over a box
PC: Coco Ma

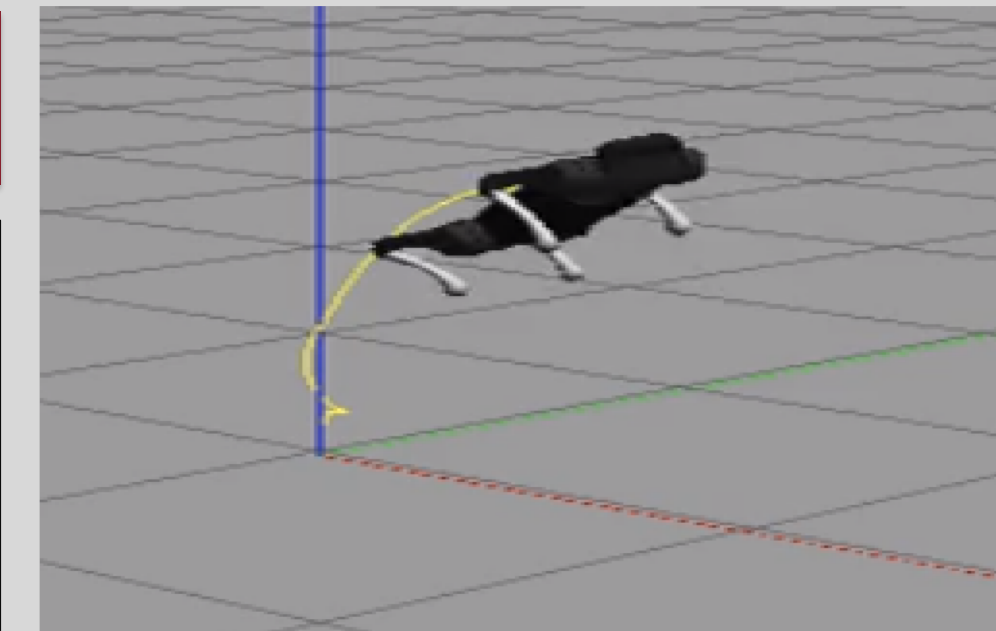
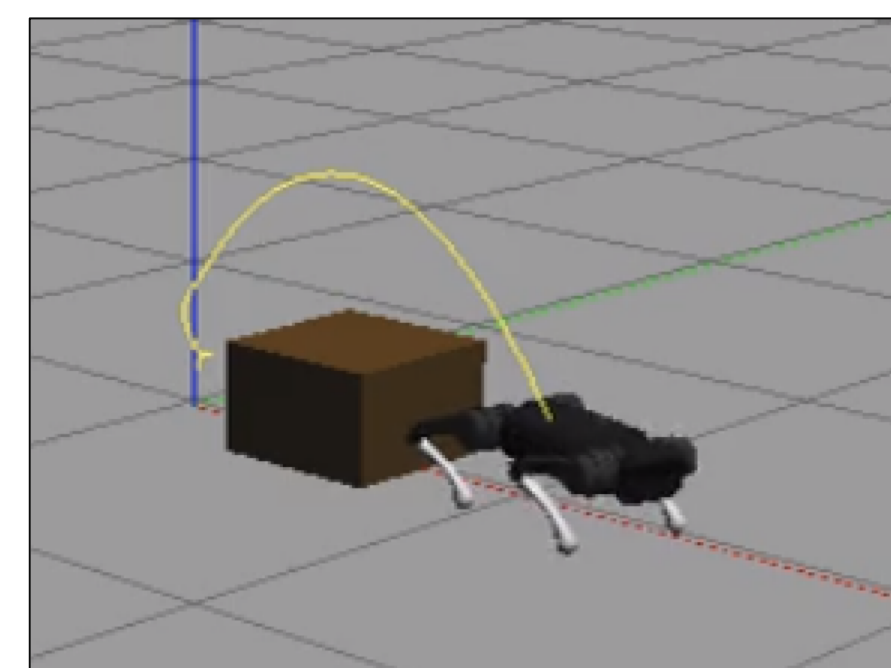
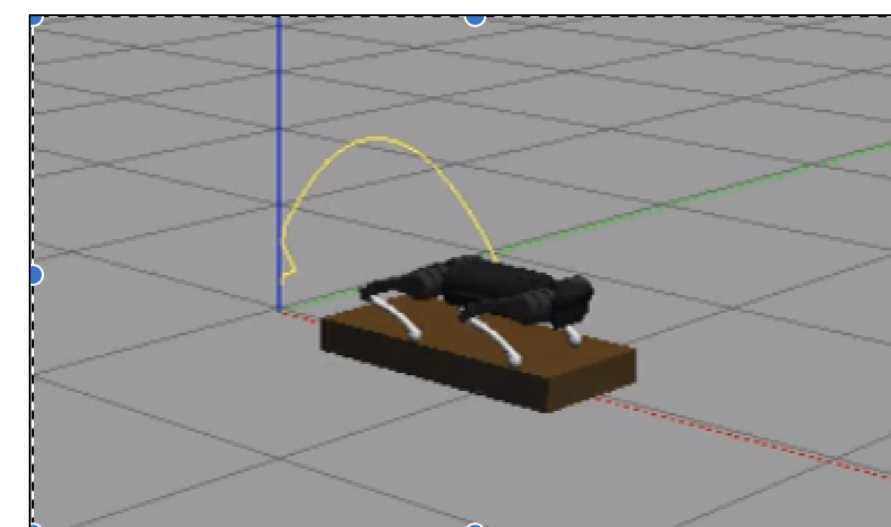


Fig. 5: 3D Simulation of robot jumping highest in ROS PC: Coco Ma

Next Steps & Citations

After attending SHINE, I acquired my new skills that are related to robot. In the future, I will use these skills to develop something new and helpful. I also hope these skills will help me during the school year.

[1]Nguyen, Q., Powell, M. J., Katz, B., Di Carlo, J., Kim, S. (2019). Optimized Jumping on the MIT Cheetah 3 Robot. In *2019 International Conference on Robotics and Automation (ICRA)* (pp. 7448-7454). IEEE.

<https://ieeexplore.ieee.org/abstract/document/8794449>

[2]Park, H. W., Wensing, P. M., Kim, S. (2015). Online planning for autonomous running jumps over obstacles in high-speed quadrupeds.

<http://hdl.handle.net/1721.1/97236>

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