# Project Portfolio: Nathan Tsao

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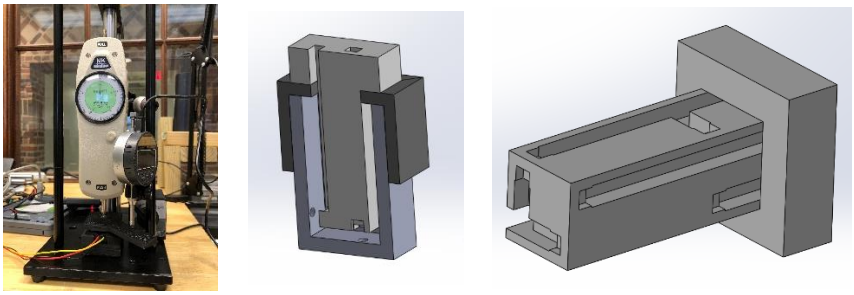
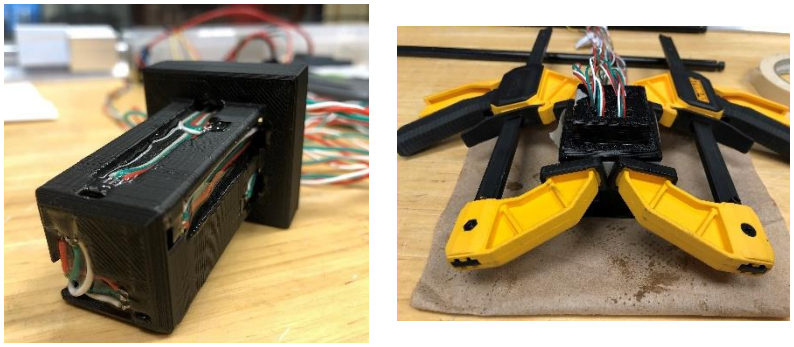
**Instrumented foot for a humanoid robot (Aug 2021 – Dec 2021, Jan 2022 –)**

In January 2022, I joined the RoboDesign Lab led by Professor Joao Ramos as an undergraduate research assistant. I am currently working on the instrumented foot project, which is a continuation of my senior design group project from the Fall 2021 semester.



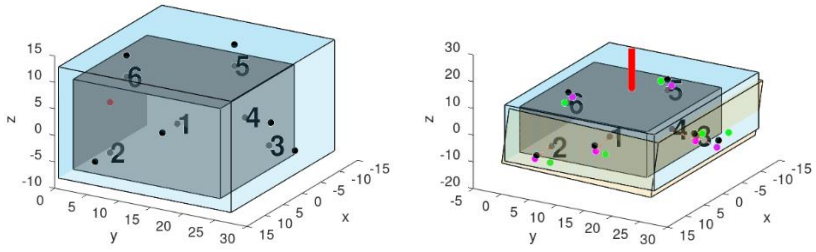
(a) (b) (c)

Figure 1. Setup for polymer compression tests (a) and CAD for prototype foot (b, c).



(a) (b)

Figure 2. Foot manufacturing process: sensors glued onto the foot (a) and waiting for polymer to cure (b).

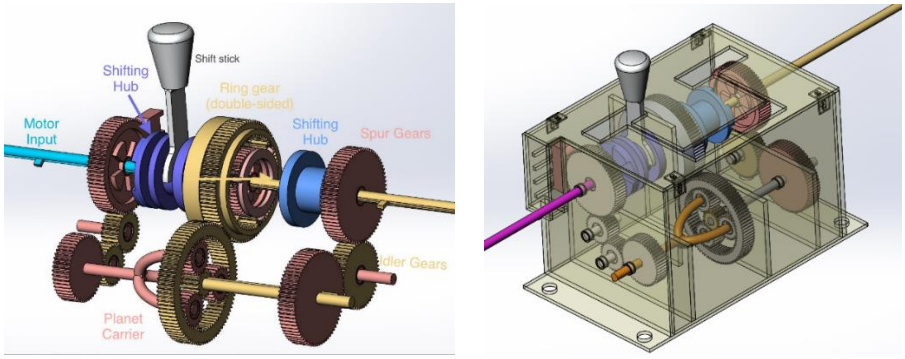



(a) (b)

Figure 3. Initial (a) and deformed (b) configuration of the simulated foot in MATLAB.

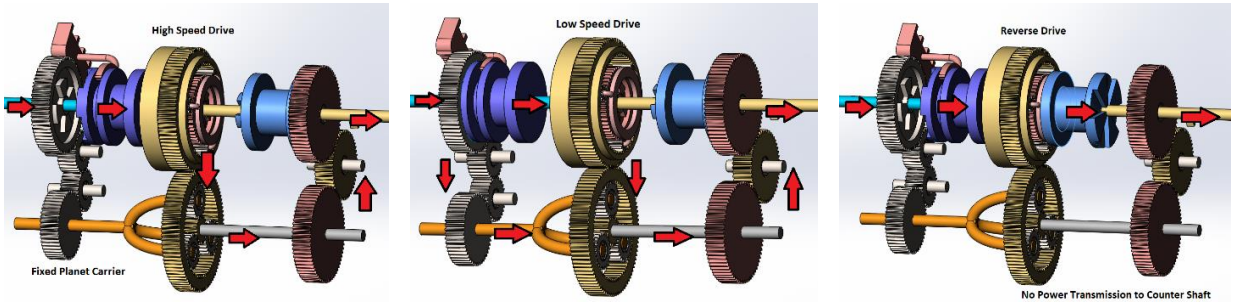
The goal of this project is to develop an instrumented foot with force-sensing capabilities for humanoid robots. Under the guidance of a PhD student in the lab, I have (1) gathered test data for the chosen polymer and sensors and (2) started manufacturing a prototype foot. During the next few weeks, I plan to test, calibrate, and iterate on the foot design.

**3-Speed Transmission Design (Jan 2021 - May 2021)**




(a) (b)

Figure 4. Labeled transmission components (a) and assembly with housing (b).




(a) (b) (c)

Figure 5. Transmission configurations: high-speed (left), low-speed (middle), and reverse drive (right).

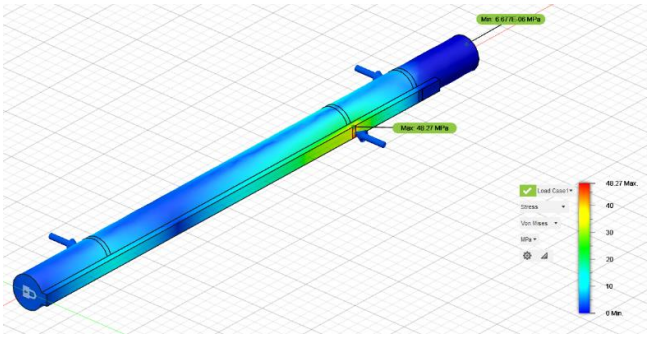


Figure 6. FEA setup and results for the transmission output shaft.

This project was a group class project for the Mechanical Design II course at UIUC. The goal of this project is to (1) design a three-speed transmission using at least one planetary gearset, (2) lift a light weight as fast as possible using a high-speed drive, and (3) lift as heavy a weight as possible using a low-speed / high-torque drive. The reaction forces on the transmission housing were analyzed using solid mechanics principles, and failure analysis was conducted on main transmission components (e.g., Figure 6, shafts) using FEA.

In this project, I was responsible for the design and CAD of the transmission and assisted in calculating housing reaction forces and performing FEA in Fusion 360. The final high-speed drive lifted the light weight at $\sim 35\ cm/s$ and the low-speed drive produced a torque up to $\sim 25\ Nm$ on the output shaft.