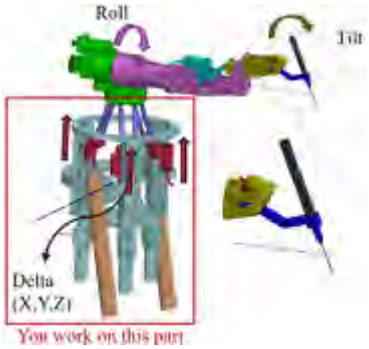
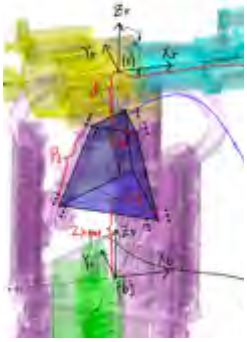
## Kinematic calibration of the 3 DOF tilting mechanism for Eye Robot 3.0

- **Goal:** Investigate the accuracy of and calibrate the 3 DOF delta robot, which includes six prismatic-spherical-spherical kinematic chains and provides XYZ translation.
- **Significance:** Delicate eye surgical procedures such as retinal vein cannulation and sub-retinal injection require very high accuracy – around 25-30 microns. To achieve that, mechanical and control errors should be carefully identified and compensated.





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- **Mechanism description:** Each of the three rotary motors moves the slider, by means of a precise ball-screw unit integrated in the linear stage. Each slider is connected to the moving platform through two spherical-spherical kinematic chains. The resultant parallel mechanism, consisting of six prismatic-spherical-spherical chains, provides three pure translations in XYZ.
- **Where to expect errors:** The positional errors mostly come from two sources: control errors at joint level, which is related to how accurate we can command the slider to go to the desired position, and mechanical errors, which is related to how accurate the lineages are fabricated and installed.
- **How to resolve:** For position feedback at the joint level (linear motion of the slider) a rotary incremental encoder, connected to the motor, and an absolute linear encoder, connected to the slider, are used. For the mechanical errors, a precise external measurement sensor (A laser tracker or an Optotrack) will be used to identify the errors, and a calibration model to compensate.



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- **What students will do:**
  - Define and achieve a proper homing position for the delta robot.
  - Design an experiment to precisely capture the actual 3D position of the moving platform using the provided measurement system (two or three spot laser trackers or an optotrack system).
  - Command the robot to travel through the entire workspace and capture command, expected and actual trajectory of the moving platform, and identify the errors.
  - Implement a calibration method to compensate for errors.
- **Deliverables:**
  - Minimum: Designing and performing the experiments.
  - Desired: Implementing the calibration.
- **Size group:** 1-2
- **Skills:** Good knowledge of Kinematics and Robotics, Familiar with robot calibration, Experienced in MATLAB and C++.
- **Mentors:** Ali Ebrahimi and Drs. Alamdar and Iordachita.