ROP project plan:
Shape sensing of TDCRs

- Journal/log to be maintained of every tutorial implemented
    - Should be an idea dump : Highlight **main concepts learnt,** include brief descriptions of findings, questions, equations, figures, outputs of tutorials
- Time for intermediate presentations not included (can be adjusted for by the buffer weeks)
- Links added are not exhaustive – needs additional research
- Expectations:
    - Update report and journal regular
    - Weekly meetings with student supervisor
    - Weekly commits + commented code
    - Attend weekly lab meeting
    - Use slack for additional questions between meetings

Weeks 1-2

OpenCV Python tutorials :

- Installation
- Loading and displaying an image + Basic arithmetic operations
- Geometric transformation of images (To be revisited while doing multi camera setup)
- Understanding features
- Introduction to SIFT

Introduction to Continuum Robotics (CSC476) lectures :

- Lecture 01 : Introduction
- Lecture 02 : Types of Continuum robots (emphasis on Tendon-driven continuum robot)
- Lecture 05 : Sensing – Tabulate advantages and disadvantages of each. Focus on why we are using multi-cameras

Sample questions to prepare for the intermediate presentation:

1. What is a continuum robot?
2. What is a TDCR ? What are the composing elements?
3. What does it mean to sense the shape of a continuum robot?
4. What sensing is for?
5. What are the different sensing strategies to do so ?
6. What are the advantages and drawbacks of each strategy ?

7. Why are we using cameras to sense the shape? Why multiple cameras instead of one?
8. What is the workflow + timeline for your project?

State of the art description of the report to be written

Weeks 3-5

~ State of the art + Research Plan presentation

- Read "[Marker Localization with a multi-camera system]"
- Mini-tutorial from Quentin on operating and using the setup
- Understand and **implement** camera calibration :
    - Find resources / open source code e.g. https://docs.opencv.org/master/d2/d1c/tutorial_multi_camera_main.html (NOT detailed)
    - Print out corresponding pattern
    - Collect images from all three cameras
    - Deciding the best location and orientation for each camera
    - Making them work in tandem
    - Calculate extrinsic and intrinsic parameters of all three cameras
- Read on use of Aruco markers and set up code :
    - Investigate if there are better alternatives
    - Input : Image from either camera , Output : Coordinates in pixels of top left corner
    - Calculate 'x' : number of Aruco markers required to establish global frame of reference
    - Stick 'x' number of markers in a rectangle on the robot base of the setup
- Gathering resources and data for multi camera calibration and setup

Weeks 6-8 :

- Implementing and setting up the three cameras
- Calculating 3D transformations between them and to 'global' coordinates

Input : pixel coordinates from each camera of any Aruco marker

Output : 2D coordinates in decided frame + the three axes (x,y,z)

~ Intermediate presentation

Sample Content for the intermediate presentation:

1. Present the workflow in a flowchart and indicate steps completed
2. Present the status of each task and corresponding progress, success or failure
3. Outline future steps
4. Present any independent research – e.g. alternatives to Aruco markers, and their #
5. Discuss further steps :
    - Will you be pursuing GUI building or TDCR detection or joint to tip mapping ? (see Weeks 11 -12)
    - Any changes to previously discussed timeline

Plan the methodology part of the report + basic outline

Weeks 8-10 :

- Converting obtained pixel dimensions to real-world dimensions
- 3D coordinates using depth mapping
- Add a physical marker to the tip of a robot and return the 3D coordinates
- Extend this to real time tracking of the robot (e,g. from an input video)

Input : Particular feature of a 3D object placed in setup

Output : 3D coordinates in decided frame + video

Weeks 11-12 :

- Documentation (preferably done alongside the project)
- Buffer for presentations and report writing
- Regrouping to decide further steps

Weeks 13-16 :

Ideas to extend the project :

Trial with a real TDCR robot / Building a GUI / Using machine learning to learn joint to tip position mapping

~ Final presentation