Assignment 1: Tendon Actuated Continuum Robots

Start of Assignment: 24.11.2016 **Assignment due: 22.12.2016**

Assignment Description

Aim of this assignment is to understand the actuation principle of tendon actuated continuum robots and their kinematic modeling.

This assignment comprises of two parts: 1) the implementation of a geometric forward kinematics model for a two segment tendon actuated continuum robot and 2) experimental evaluation, where the performance and accuracy of the implemented forward kinematics geometric model will be evaluated by using a provided robot prototype.

This assignment will have an impact on your overall class grade by 20%. At the end, you will receive a grade on your implemented geometric model and on the experimental evaluation.

Task 1: Geometric Modeling of a Tendon Actuated Continuum Robot

The forward geometric model should be specifically implemented for the provided tendon actuated prototype (see Tutorial 1 for further specifications). Therefore, your model should consider two segments, three tendons per segment, the routing of the tendons and the following robot parameters:

	Segment 1	**Segment 2**
Number of disks per segment	10	10
Disk radius	8	8
Disk pitch circle radius	6.5	5
Disk height	3	3
Segment length	92	102

You will receive the following files to implement your model:

- runGeometricModeling.m
- GeometricModel.m
- drawRobot.m

Please use the provided script file (runGeometricModeling.m) to define the specific robot parameters and also to run your implemented model by using configurational parameters as inputs ($q = [\Delta\ell_{11}, \Delta\ell_{12}, \Delta\ell_{13}, \Delta\ell_{21}, \Delta\ell_{22}, \Delta\ell_{23}]$.). Within this script file call the two provided functions to determine the position and orientation of the robot's space curve (GeometricModel.m) and also to visualize the robot in 3D space (drawRobot.m).

Implement the geometric forward kinematic model using GNU Octave or Matlab. You can download GNU Octave here: https://www.gnu.org/software/octave/.

Task 2: Experimental Evaluation

Goal of this task is the experimental evaluation of your implemented forward kinematics model by using a provided robot prototype and a 3D measurement arm, the MicroScribe MX (http://www.3d-microscribe.com/).

The experimental evaluation will take place in our lab. Please make an appointment as a group (during office hours) for the experimental procedure. Prior starting the experiment, you will receive instructions on how to use the MicroScribe MX by a tutor and a short manual. Further, you will receive instructions on how to operate the robot prototype and use the graphical user interface (GUI).

Perform the following steps to evaluate your implemented forward kinematics model:

- Choose the following 10 configurations in actuator space ($q_n = [\Delta\ell_{11}, \Delta\ell_{12}, \Delta\ell_{13}, \Delta\ell_{21}, \Delta\ell_{22}, \Delta\ell_{23}]$) as inputs to the GUI. All numbers are in mm. A negative number means that the tendon is being pulled, a positive that it is being pushed.

	$\Delta\boldsymbol{\ell}_{11}$	$\Delta\boldsymbol{\ell}_{12}$	$\Delta\boldsymbol{\ell}_{13}$	$\Delta\boldsymbol{\ell}_{21}$	$\Delta\boldsymbol{\ell}_{22}$	$\Delta\boldsymbol{\ell}_{23}$
1	-3	1.5	1.5	-4	2	2
2	-3	1.5	1.5	2	-1	-1
3	0	0	0	-4	2	2
4	0	0	0	-2.5	-2.5	5
5	3	-2	-1	-3	1	2

6	3.6	-1.2	-2.4	3	-1	-2
7	3.6	-1.2	-2.4	0	0	0
8	-3	1.5	1.5	0	0	0
9	-3	1.5	1.5	-1	-2	3
10	1.4	-2.2	0.8	1.6	0.8	-2.4

- Once the robot has reached the specific configuration, use the 3D measurement arm to measure points along the robot's backbone at each disk's bottom centerpoint. Use the provided excel file to capture your results.
- Use the same n configurations as inputs to your geometric model and compute the robot's backbone.
- Visualize the robot's measured backbone together with the computed backbone for each configuration in a separate figure and save it.
- Compute the maximum and mean Euclidean distance between measured and computed points and capture your results within the provided excel file.

Lastly, discuss your results and capture them in the provided excel file. How well is the accuracy of your implemented model? How could the accuracy be improved? Which parameters influence the accuracy?

Task 3: Turn in Assignment

The assignment is due on December 22, 2016. Turn in your code files, your figures and the excel file with your captured results as a group. Send an email with your assignment, names and matriculation numbers to: continuumrobotics@lkr.uni-hannover.de. Don't forget to document the code files!