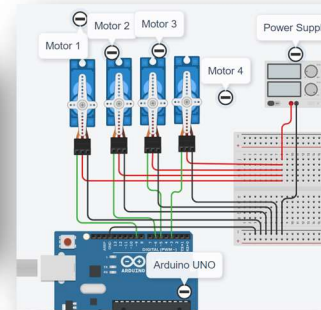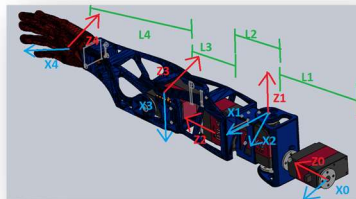# Robotics EDPT 1009
Modeling and Control of Poppy Humanoid Robot Arm used for Teeth-Brushing inspired by Spiderman
Winter 2022

Abstract: An open-source Poppy humanoid robotic hand was created in this work to aid in service robotics. The application aimed to brush the teeth by developing a movement sequence for the hand. SIMSCAPE Multibody in SIMULINK and MATLAB is used for the software, while the hardware is designed and implemented in SOLIDWORKS, 3D-printed in PLA+ material. First, the forward position kinematics is obtained by using the DH convention, followed by the inverse position kinematics by Newton Raphson's numerical method. Both were tested and compared to the actual values obtained from the robot dimensions. Then test trajectory tracking using the equation for a straight line for 2 movements, the first forward and the other backward.

Hand

Forearm

Upper Arm

Arm Connector

Shoulder
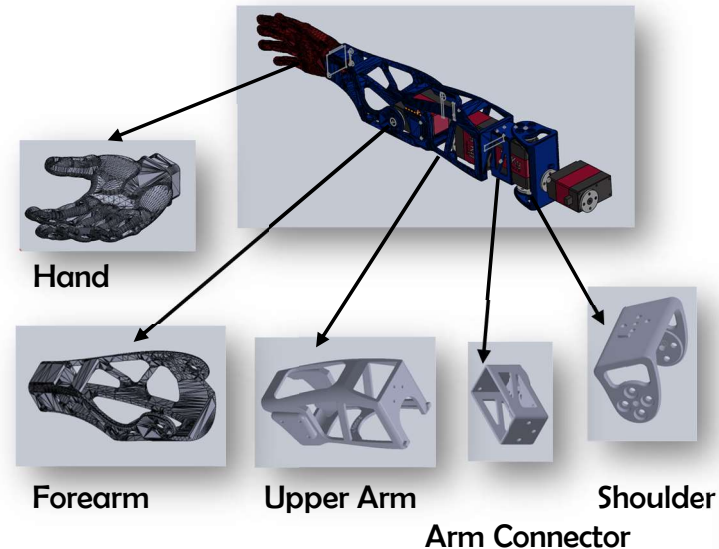
Methodology: To obtain the forward and inverse kinematics, the DH convention is obtained.

Joints	θ	d	a	α
1	q_1	l_1	0	90°
2	q_2	0	0	-90°
3	$q_3 + 90^o$	$l_2 + l_3$	0	-90°
4	$q_4 - 90^o$	0	l_4	0

|	
l_1	2.7cm
l_2	3.5cm
l_3	10.57cm
l_4	15.07cm

Pseudocode for Inverse Kinematics
Initial guess for the angles
Input error
while(difference error<error){
qn+1 = qn – inverse jacobian*forward kinematics
Calculate the new difference error }

Scan me!
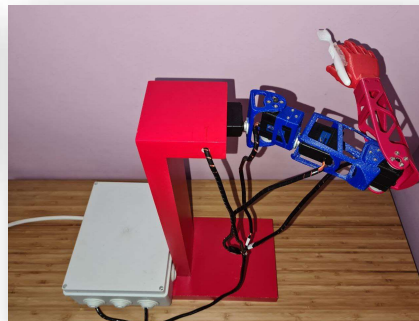
Results: Testing the forward kinematics function by comparing the real or measured values from the transform sensor in SIMSCAPE to the calculated function and observing a very small error inputting angles $0^o, 30^o, 45^o, 90^o$:

| -22.58 |
| -5.025 |
| 6.619 |
real(x,y,z)

| -22.05 |
| -7.241 |
| 6.938 |
DH(x,y,z)
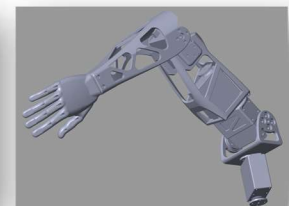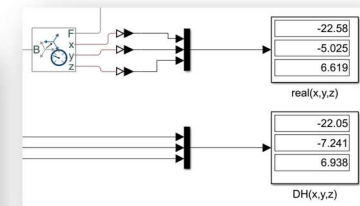
Trajectory: 2 trajectories: 1 forward and another backward
To maintain continuous motion, the equations of a straight line traversing x=-20.75 cm to -7.774 cm changing only 2 angles, q2 and q4, Ts is the sampling time

$$x = -7.774 - 2.5952 * Ts$$

$$x = -33.726 + 2.5952 * Ts$$

Backward
Forward

q2 range

q4 range

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