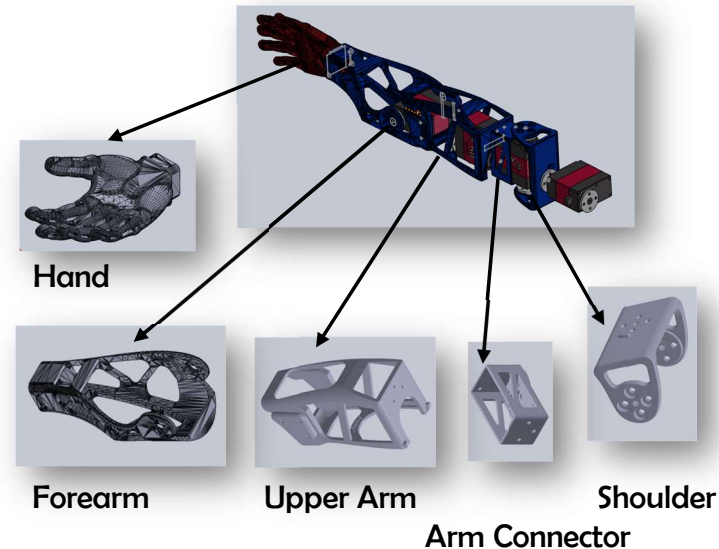


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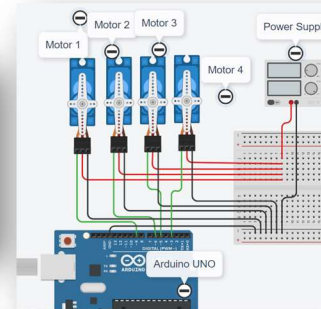
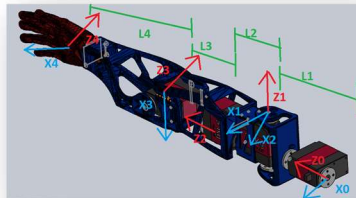
Modeling and Control of Poppy Humanoid Robot Arm used for Teeth-Brushing inspired by Spiderman Winter 2022

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.



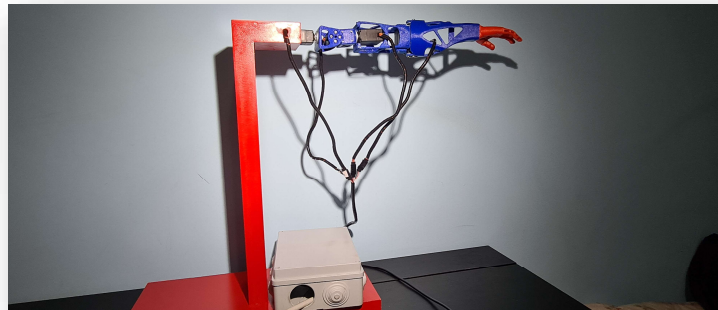
Methodology: To obtain the forward and inverse kinematics, the DH convention is obtained.

Joints	θ	d	a	α	l_1	l_2	l_3	l_4
1	q_1	l_1	0	90°	2.7cm	3.5cm	10.57cm	15.07cm
2	q_2	0	0	-90°				
3	$q_3 + 90^\circ$	$l_2 + l_3$	0	-90°				
4	$q_4 - 90^\circ$	0	l_4	0				

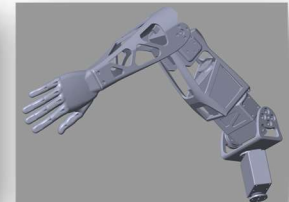
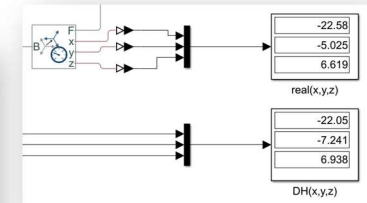


Pseudocode for Inverse Kinematics

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



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 $0^\circ, 30^\circ, 45^\circ, 90^\circ$:



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, q_2 and q_4 , T_s is the sampling time

$$x = -7.774 - 2.5952 * T_s$$

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

