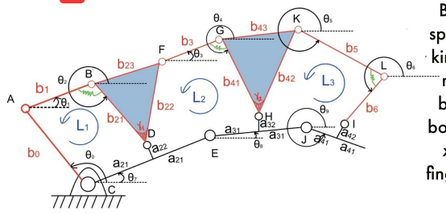
TEDex

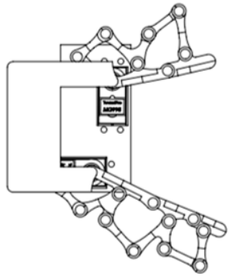
DEXTEROUS·EXOSKELETON

Mechanism Design



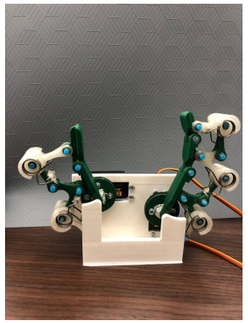
index finger mechanism design

Both inverse kinematic, by defining a specific finger motion and a given spring angle finding the motor torque and two spring angles, and forward kinematic, by defining the motor torque and spring angles and finding the motion, accordingly, are separately applied as mechanism analysis. In both techniques, a coordinate system has been fixed at the center of the bottom joint of the link b0 all angles are measured with respect to the fixed x axis. The visual representation of the linkage-based index and thumb finger mechanisms are given in figure 28 and figure 29, respectively. Here, thumb finger is the same mechanism that is used for index finger, only without loop 3 and its components.



index finger solid design

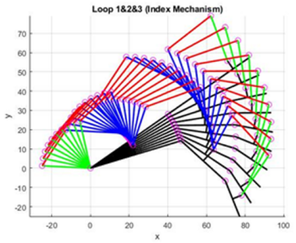
After obtaining the results from these optimization steps, a solid model of the mechanism is drawn in the SolidWorks according to results by changing the rustic model that is previously created. This solid model is maybe the most important part as it connects two important parts: manufacturing and simulation.



index finger working prototype

It is probably much more complex to design an underactuated mechanism instead of a fully actuated mechanism, but it also conforms to the concerns about anthropomorphic motion and appearance. It allows to provide more natural movements. One of the most important thing that is derived from this work is the ability to do kinematic and kinetic analysis after trying multiple times; understanding the need of doing these analyses, the purpose of optimizing and simulation of the work.

Optimization

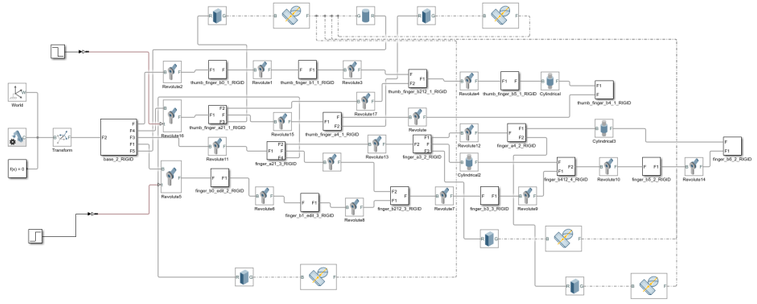


index finger optimized link lentghs on action

Optimization is performed with the genetic algorithm provided by the global optimization add-on in MATLAB. Upper bound and lover bounds given to the genetic algorithm. Finger lengths to be taken as constant remain, they are not included in the optimization, initial values are determined and used in a way to have anthropomorphic characteristics. Variable angles are calculated thanks to the loop closure equations obtained with inverse kinematics

Simulation

Simulation is made via Simscape Multibody. The solid model is directly imported to the software and arranged in the Simscape. A cylindrical object is defined to the system and motion is given with contact force block.



Simscape Multibody block diagram

PROBLEM STATEMENT

Designing and manufacturing two underactuated anthropomorphic robotic fingers mimicking index and thumb fingers, driven by an exoskeleton structure.

WHAT IS

"Underactuated"

Underactuation is a technology that allows robotic fingers to adaptively grasp objects in different sizes and shapes by having less number of actuaters than the degrees of freedom.

"Exoskeleton"

Series of linkages that are connected to the hand or mechanism externally, which are attached to each other by joints.

"Anthropomorphic"

Anthropomorphic basically means "human-like". The base of the assembly is inspired from the metacarpals whilst first, second and third links of the mechanism were inspired from the proximal, intermediate, and distal phalanges.

AREAS OF USAGE

Rehabilitation

Augemantation

Assistance

Aykut Bakan
Kenan Mert Demirel
Berk Karaman