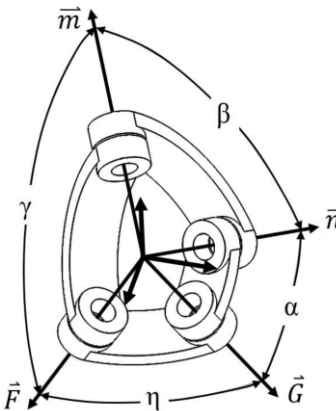


SERIAL CHAINS OF SPHERICAL FOUR-BAR MECHANISMS TO ACHIEVE DESIGN HELICES

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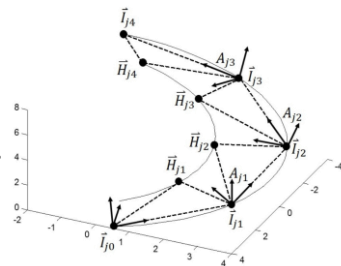
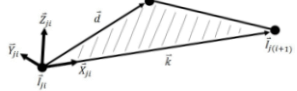
SPHERICAL FOUR-BAR MECHANISMS



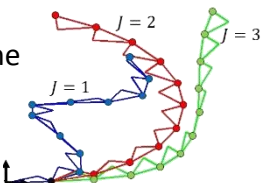
Motion is defined by the angle between each joint axis. Serial chains may be formed by connecting the coupler of one four-bar to the base link of the next.

DESIGN HELICES

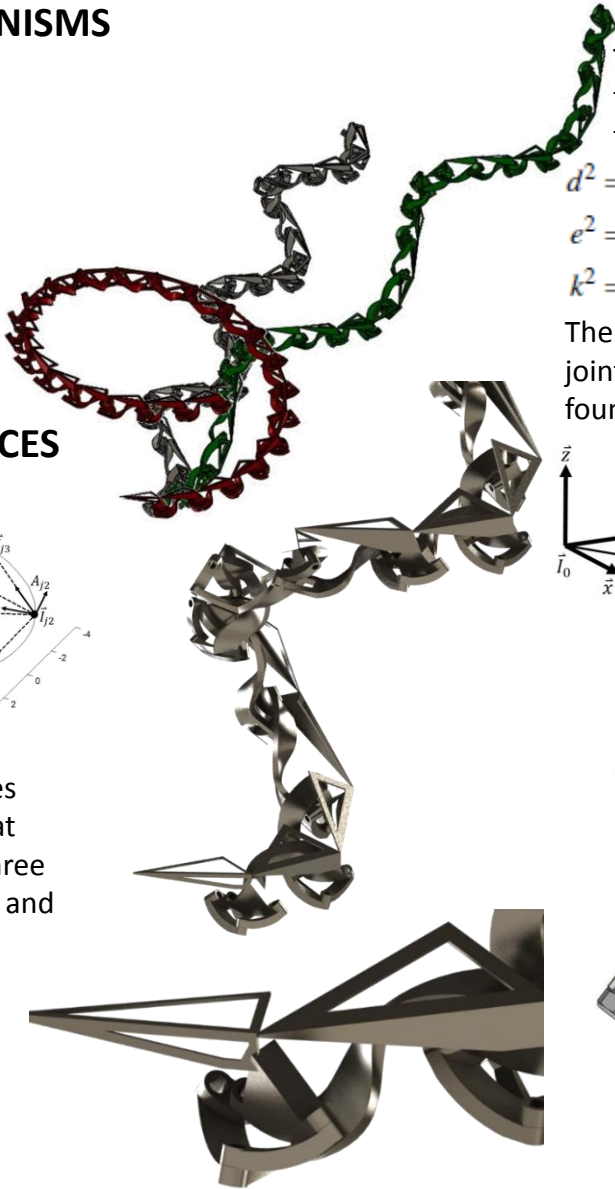
Points on the design and companion helix identify the triangular body below.



Three design helices with their centers at the origin define three unique start points and targets for the mechanism.



The helices are transformed to have the same starting base defined by the first triangular body.



DESIGNING THE SPHERICAL JOINT

The triangular body parameters are solved for using these equations. These values are constant for all the helices.

$$d^2 = J_j^2 + r_j^2 + h_j^2 + b_j^2 \phi_j^2 - 2r_j h_j \cos(\phi_j - \theta_j) - 2J_j b_j \phi_j,$$

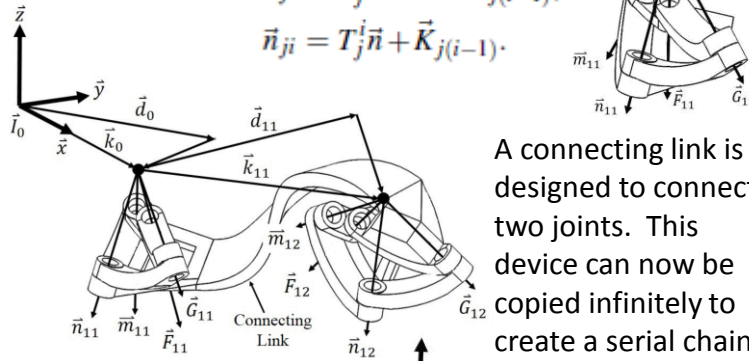
$$e^2 = J_j^2 + r_j^2 - 2\cos(\phi_j) r_j h_j + h_j^2,$$

$$k^2 = b_j^2 \phi_j^2 + 2h_j^2 - 2h_j^2 \cos(\phi_j).$$

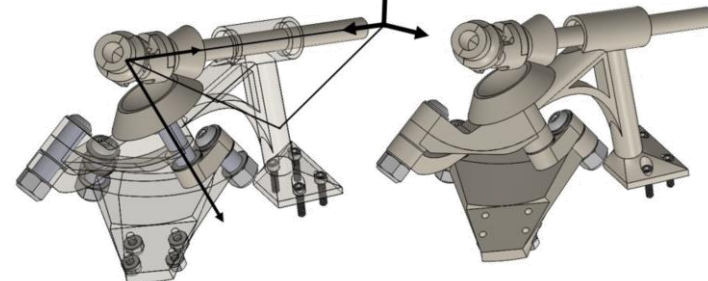
The geometry of the joint to be copied is found with.

$$\vec{G}_{ji} = T_j^{(i-1)} \vec{G} + \vec{K}_{j(i-1)},$$

$$\vec{n}_{ji} = T_j^i \vec{n} + \vec{K}_{j(i-1)}.$$



A connecting link is designed to connect two joints. This device can now be copied infinitely to create a serial chain.



A shaft connected with universal joints can be used to actuate the device.