Transformable Design HW 1

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1 Mechanism In Multiple Configurations

Diagrams 1, 2, **??** show an example of a closed loop of scissor mechanism with a single degree of freedom. These were constructed with a grasshopper model that takes as input an arbitrary closed curve whose control points serve as crossing nodes for the scissor network. This is described further in 1.1.

Note that the code does not impose constraints associated with self intersection. Thus it is possible to simulate a state of the network that is beyond 'fully closed'.

1.1 Grasshopper Model

This section describes the functionality of a grasshopper module that can be used to design arbitrary planar scissor networks with a single DOF. This model generates the linkages and simulated configuration by a sequence of operations that is, qualitatively:

1. Fit an arbitrary rhomboid (rhomboids vary by a single DOF, the opening angle between a pair of legs θ_0) to a pair of adjacent knots p_1, p_2 on the skeleton.

2. Measure the length of edges of this rhomboid, l_0.

3. Generate the transformed skeleton coordinates by scaling the original form.

4. Create a new rhomboid between the transformed knots p'_0, p'_1 with edge length l_0. (Note that the internal angle will not in general be $theta_0$, which is exactly the change in shape of the rhomboid due to the global reconfiguration.). Call this rhomboid $\mathbf{R}'$

5. For every pair of knots, place a rhomboid similar to $\mathbf{R}'$ (i.e. differing only by scaling).

6. Construct skeleton of physical linkages by joining legs of adjacent rhomboids (see figures).

7. Trace skeleton to create physical linkage form, and add holes for shafts.

This simulation is parameterized by:

1. initial configuration

   (a) $\{p_i\}$: An ordered sequence of points (knots of a polyline).
   (b) θ_0: Internal angle of the rhombi on the initial configuration as defined by $\{p_i\}$.

2. displacement/scaling

   (a) v: scaling factor, amount to change size of form.

3. physical linkage

   (a) w: link width, size from edge to edge of physical link.
   (b) h: hole size, radius of holes for pins.

1.2   Code

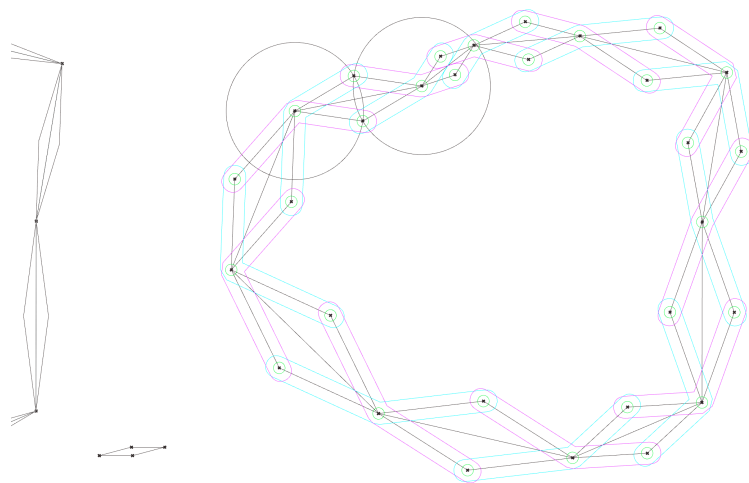Code for this HW can be found at this link.
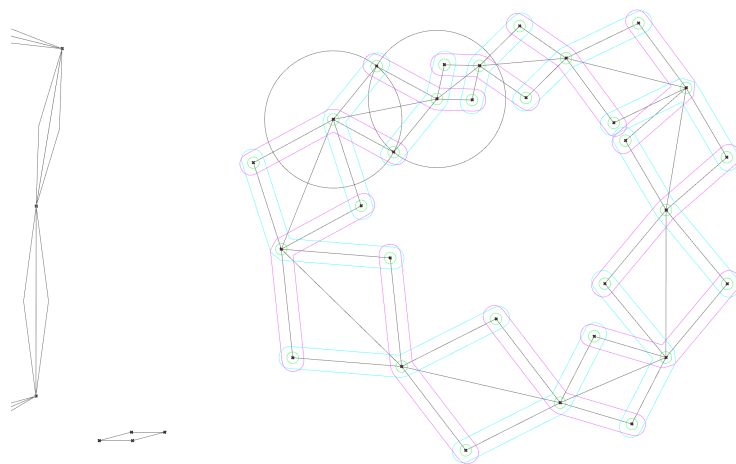
Figure 1: Mechanism in open configuration.
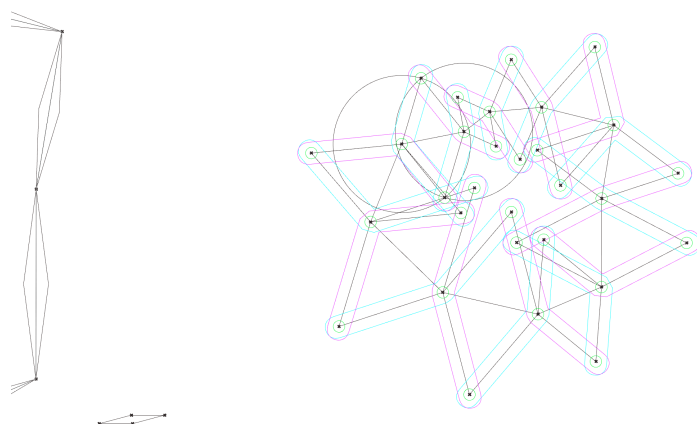
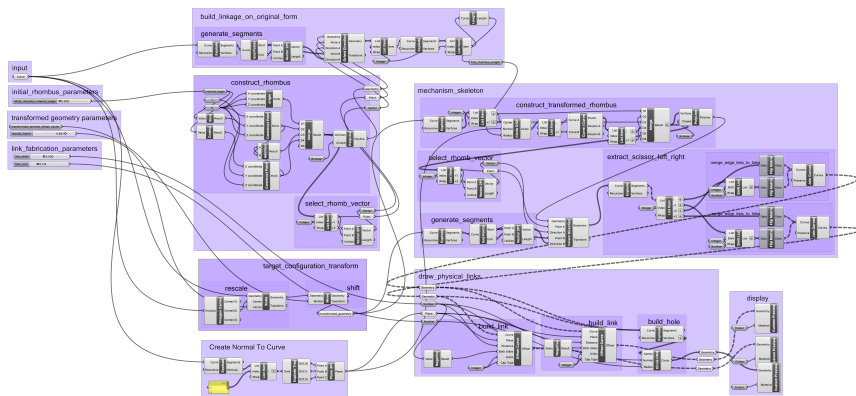Figure 2: Mechanism in partially closed configuration.

Figure 3: Mechanism past "closed" configuration.

Figure 4: Overview of Grasshopper model.