Tablet

The project team will create a display surface (the **tablet**) with a four degree-of-freedom robotic mechanism (the **robot**) hidden behind it, and a glove or pair of finger cots (the **wearable**) to be worn by the user. The thumb tip and first fingertip of the glove will incorporate permanent magnets or ferromagnetic material which can couple through the tablet surface to electromagnetic (or actuated permanent magnet) end effectors on the robot. Through this coupling, the robot will produce forces on the fingertips tangent to the display.

The device will support the following interactive modes:

1. Free motion - the user can move the two contact points freely with minimal force
2. Path constraint - the user feels the motion of the contact points constrained along a path
3. Unilateral constraint - the user feels the motion of the contact points constrained unilaterally, as if colliding with a stiff wall
4. Pinch constraint - a unilateral constraint is enforced on the distance between the two contact points
5. Active force - the user feels the contact points actively pushed or pulled in a particular direction along the display surface
6. Rigid body - the user feels forces on the two contact points consistent with a planar wrench applied to a rigid body attached at the two contact points

Example user stories:

- The tablet displays a collection of slider controls to the user. When touched, these controls constrain the fingertip to move along a single axis.
- The tablet displays a simulated planar rigid body. The user can move this body around on the screen by touching it with two fingers. The forces and torque experienced by the object as it collides with obstacles in the simulation are felt by the user.

Questions to drive quantitative requirements:

How large does the workspace need to be?
How far apart do the two contact points need to get?
How close together do the two contact points need to get?
How free should free motion be?
    How much inertia?
    How much damping?
    Maximum speed?
How stiff should stiff walls be?
What positional/angular resolution is required?
What force resolution is required?
What variables need sensors?
How strong should constraints be?

Force from actuators

Strength of magnetic coupling through tablet

What should the bandwidth be?

From which input to which output?

Questions to drive qualitative requirements:

Should we require a display?

What should coming into contact with the surface feel like?

What should coming out of contact with the surface feel like?

Do the two contact points have any allowable motion constraints (e.g. rotation limits)

What range of hand sizes needs to be supported?

What use cases / demos will best illustrate the utility of this device?