Collateral Control Systems for Surgical Training

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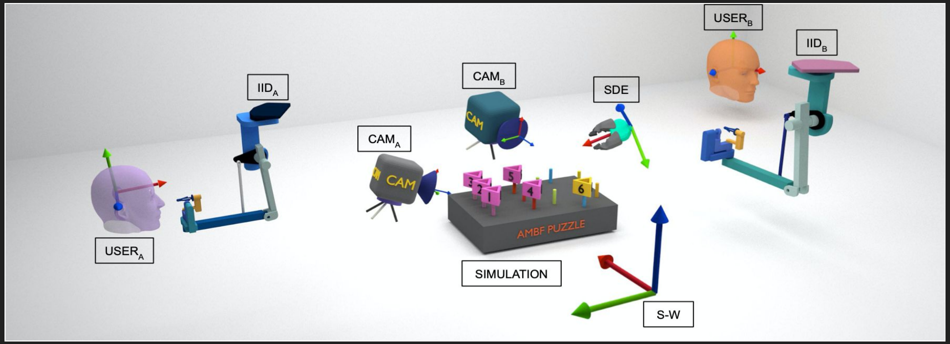
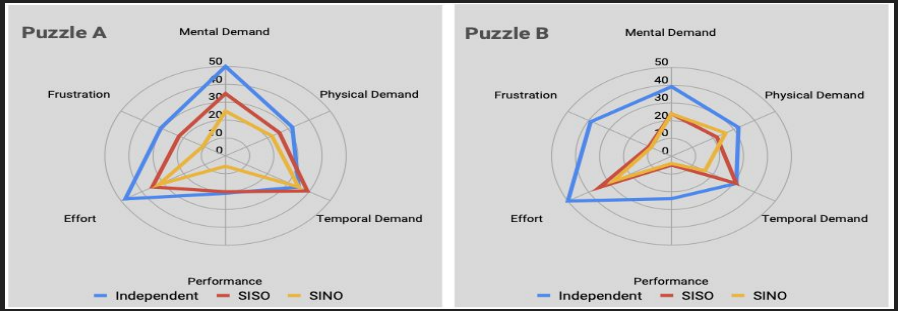
Quick Summary

Collateral Control schemes for AMBF simulator

Training Puzzles for simulator

Data Collection Script for performance metrics inside simulator





Dual Control Implementation and Schemes

We’ve developed 4 different control schemes by manipulating these haptic and angular gain variables:

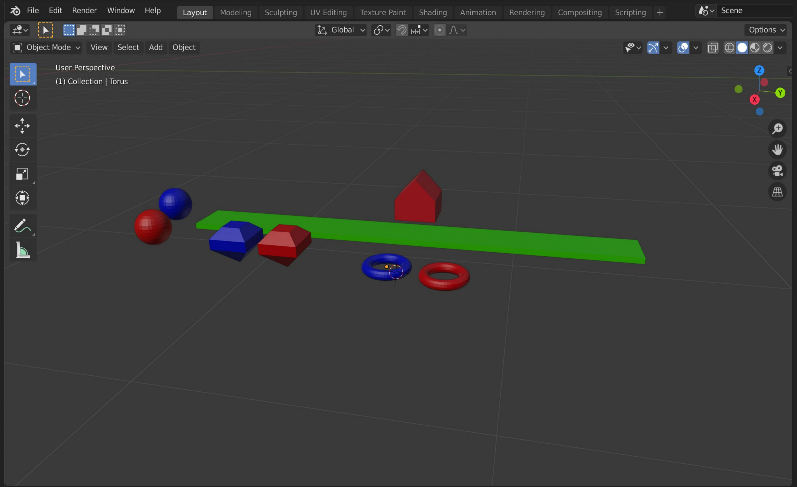
1. Symmetric Input, Symmetric Output
2. Symmetric Input, Asymmetric Output
3. Asymmetric Input, Symmetric Output
4. Asymmetric Input, Asymmetric Output

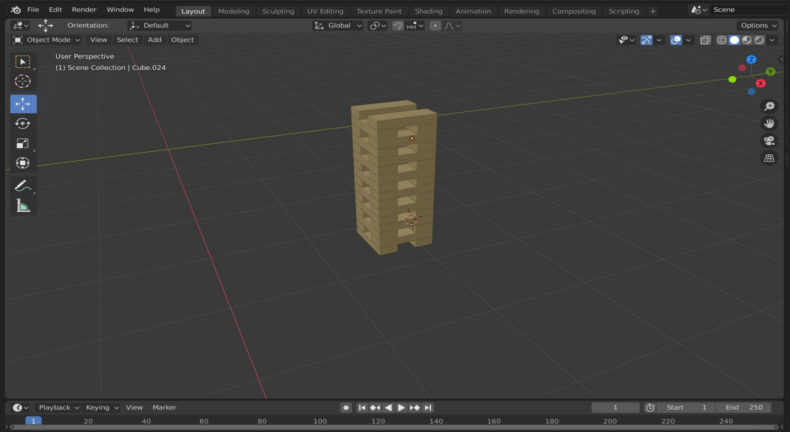
```
simulated multibody: "Gripper.yaml"
# root link: palm_link
haptic gain: {
    linear: [0.05, 0.05, 0.05],
    angular: [0.0, 0.0, 0.0]
  },
controller gain: {
  linear: {
    P: [200.0, 200.0, 200.0],
    D: [20.0, 20.0, 20.0]
  },
  angular:  {
    P: [20.0, 5.0, 10.0],
    D: [2.0, 0.5, 1.0]
  },
```

Training Puzzles

We have created 4 puzzles so far in Blender and will upload them to the simulator this week

1. Jenga
2. Threading string through hoops
3. 3D Tetris
4. Seesaw balancing





Data Collection Script

Collects poses from the 2 dVRK consoles (left and right arms recorded separately) from the ROS topics that publish pose coordinates and timestamps using the rospy.Time class, then write collected data to a text file.

Using each set of poses we can calculate:

- Total path length(Γ)
- Orientation(Θ)
- Approximate Motion Smoothness(Ψ)

For each of the 4 arms.

Data Collection Script (cont.)

We can then calculate normalized constants:

$$\alpha_{\Gamma}(T) = 1 - \left| \frac{\Gamma_{m_2}(t) - \Gamma_{m_1}(t)}{\Gamma_{m_2}(t) + \Gamma_{m_1}(t)} \right|$$

$$\alpha_{\Theta}(t) = 1 - \left| \frac{\Theta_{m_2}(t) - \Theta_{m_1}(t)}{\Theta_{m_2}(t) + \Theta_{m_1}(t)} \right|$$

$$\alpha_{\Psi}(t) = 1 - \left| \frac{\Psi_{m_2}(t) - \Psi_{m_1}(t)}{\Psi_{m_2}(t) + \Psi_{m_1}(t)} \right|$$

For the left and right pairs of arms. We can then plot these constants against time(6 total plots) to analyze the trainee's performance compared to the expert.