

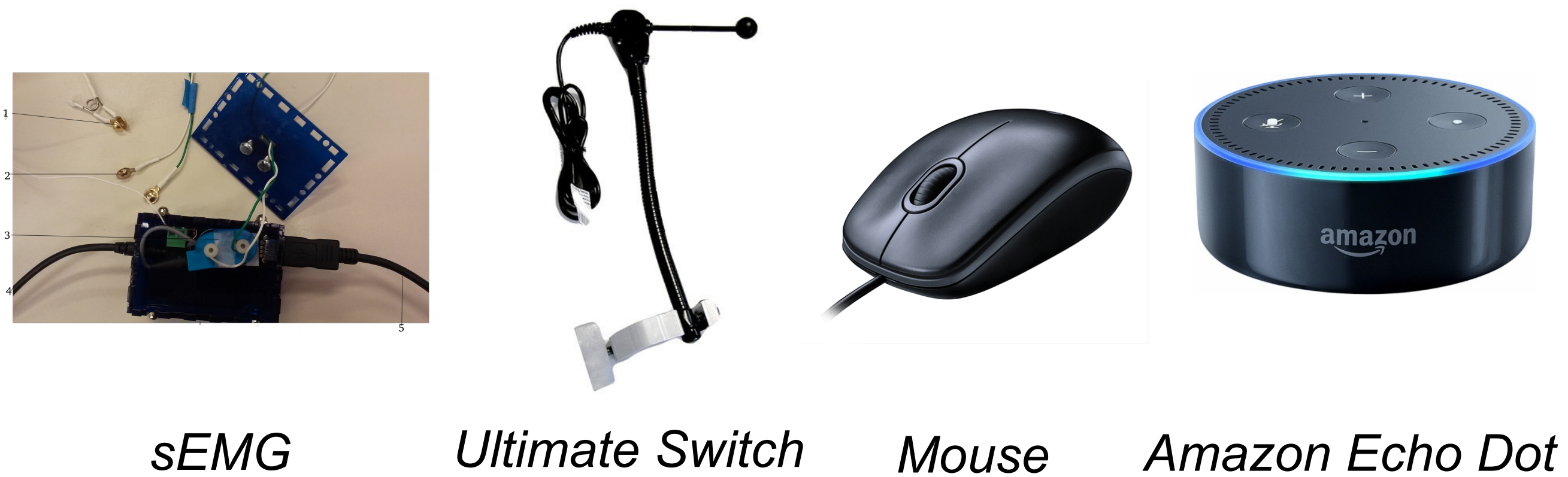
Human Robot Interface for Assistive Grasping

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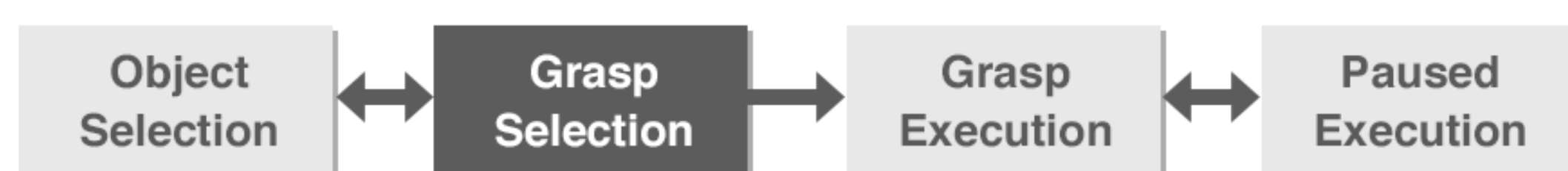
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Abstract

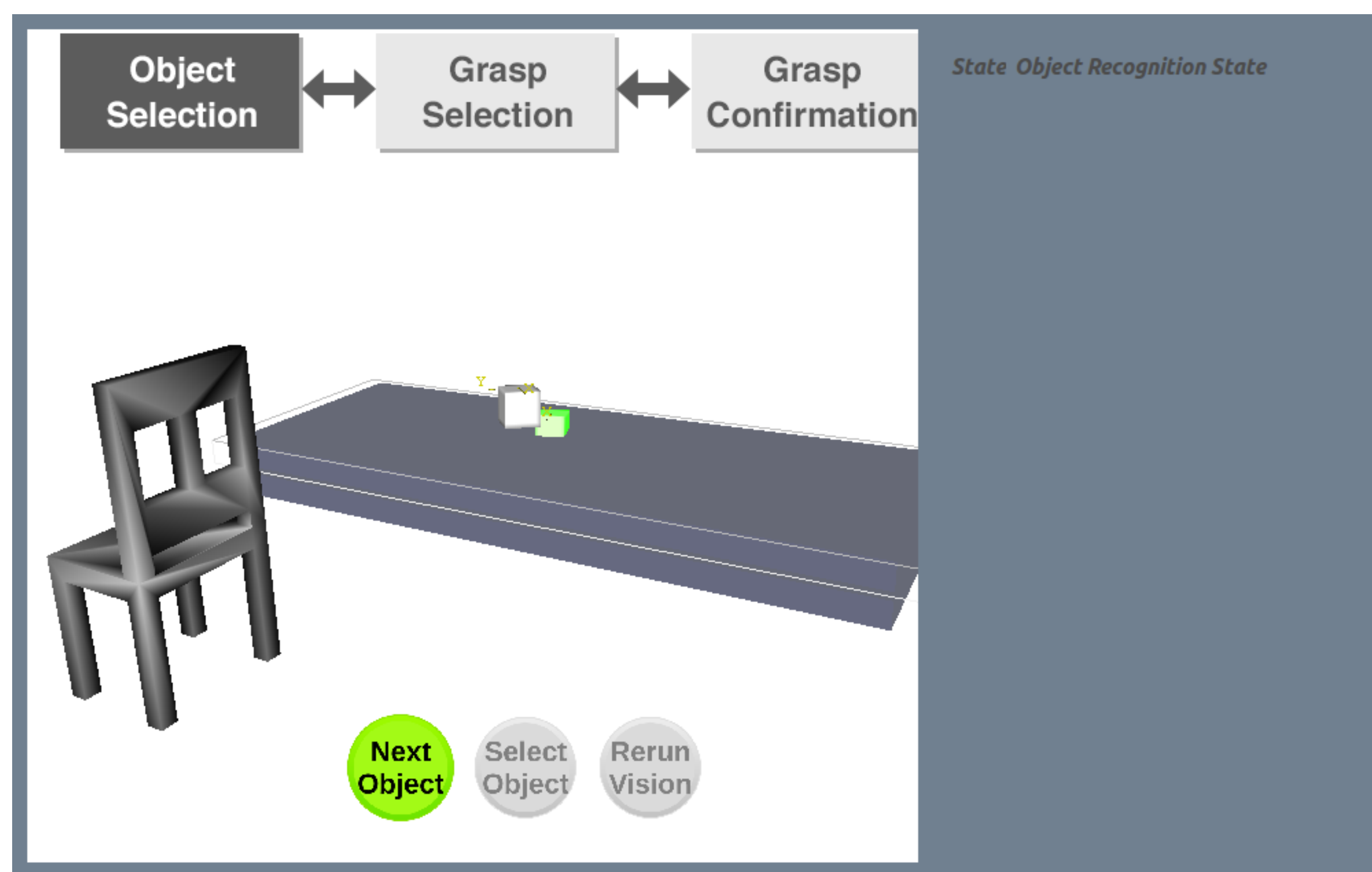
- New human-in-the-loop assistive grasping system
- Define a set of quantitative metrics to assess effectiveness of system
- All devices performed similarly for time to input and success rate



User Interface



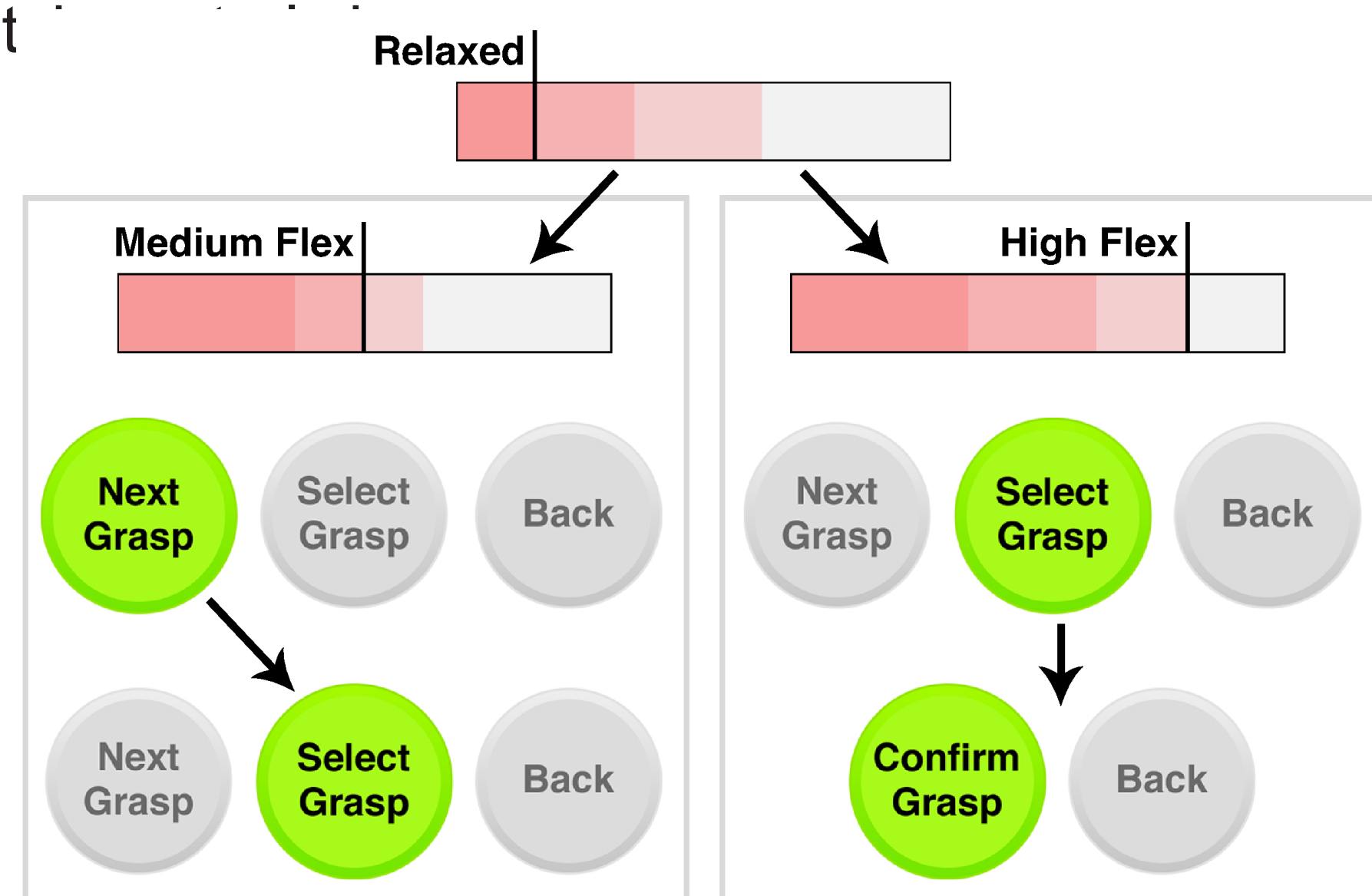
- User interacts with the system using a series of different devices, any of which can be used at any given time
- Four stages of commands simplifies the system for the user
- Grasp reachability and execution are powered by Graspit! and Moveit!
- User can stop execution at any time in the event the arm fails or is about to collide with the environment



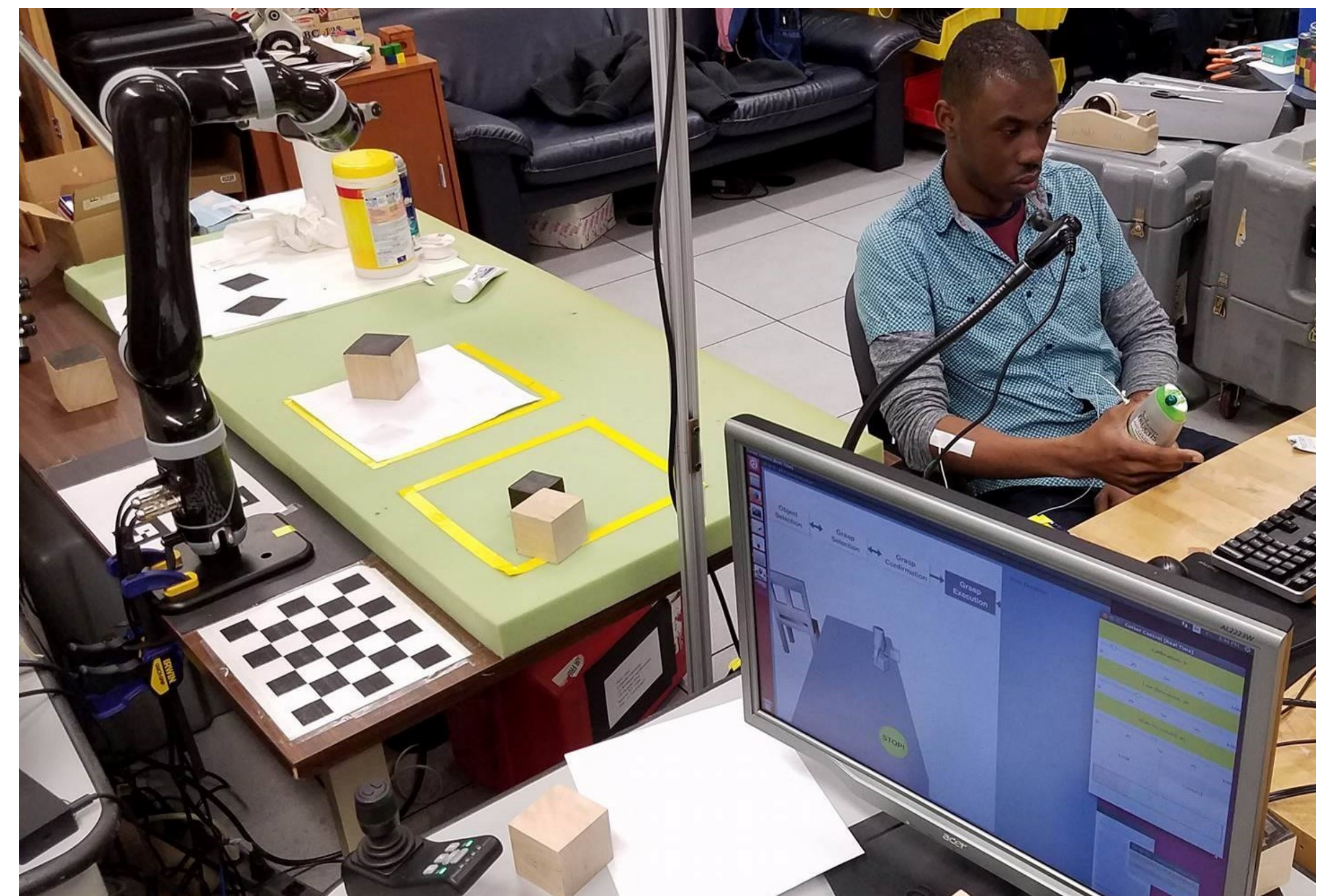
User Interface with two blocks on the table

User Input

- Alexa for voice input reading the commands on the screen
- Ultimate switch, a toggle switch, was a device that sent a binary signal depending on length of press
- sEMG device which provided a binary signal for how forceful the flex was
- Binary switch



sEMG flexing types and how the binary input affects the UI



User running experiment with sEMG

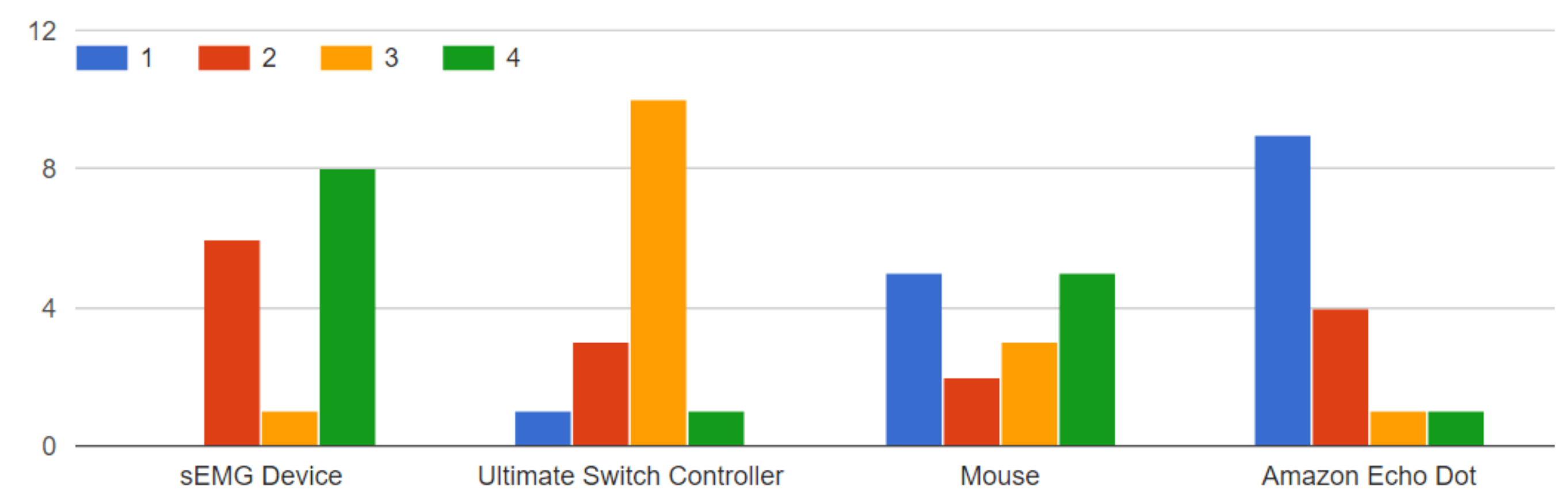
User Experiments

- 15 subjects used a mouse, ultimate switch, and Alexa. They were randomly assigned to either the forearm or the ear for the sEMG
- **Task:** Choose object and choose grasp for pick and place
 - Object was either a block or a YCB Object

Results

- Time for all devices was roughly the same
- Robot had 100% success rate at picking up blocks
- Users had 76.53% success rate at picking up YCB object
- Average success rate was 94.13%
- Success rate for sEMG device was equivalent to other device success rates

Rank each of the devices by preference



Preferences of each input device versus the other input devices (1 is best)

Average time per input device				
Activity	Mouse (s)	Alexa (s)	Switch (s)	sEMG (s)
explain interface	169.58	80.76	78.97	314.15
user block 1	20.5	18	20.5	18.0
robot block 1	63.7	40.87	48.05	53.01
user block 2	33.43	23	38.5	27.3
robot block 2	60.39	53.52	49.548	50.07
user block 3	21.5	17	28	13
robot block 3	61.18	60.39	74.335	68.27
user YCB bottle	23	74.14	77.09	124.24
robot YCB object	73.39	40.91	67.71	65.7

Average input times per device in seconds. All devices took roughly the same amount of time except for the mouse.

Number of successful grasps						
Activity	Mouse 15 trials	Alexa 15 trials	Switch 15 trials	sEMG (forearm) 7 trials	sEMG (behind ear) 8 trials	Average
Block 1	100%	100%	100%	100%	100%	100%
Block 2	100%	100%	100%	100%	100%	100%
Block 3	100%	100%	100%	100%	100%	100%
YCB Object	66.67%	80%	80%	71.43%	87.50%	76.53%
Average	92%	95%	95%	93%	97%	94.13%

Average success rate of each device. All devices had roughly the same success rate except for the mouse.