Inputs and Outputs

LabView			
Inputs		**Outputs**	
Neural Decode	MATLAB	Decode Method	MATLAB
Trained Transfer Matrix/Information	MATLAB	Training Task/Trial Information	MATLAB
Residual Limb Movements	Vicon	Task/Trial Information	Unity
Hand Movements	Unity	Vicon Control	Vicon
Audio	Microphone	Data Streams/Markers	Hard Drive

MATLAB			
Inputs		**Outputs**	
Training Task/Trial Information	LabView	Trained Transfer Matrix/Information	LabView
Decode Method	LabView	Neural Decode	LabView
Hand Movements	Unity	Neural Decode	Unity
Streaming Neural Data	TDT PO8e Card		

Unity			
Inputs		**Outputs**	
Hand/Finger Movements	Leap Motion	Hand/Finger Movements	MATLAB
Residual Limb Movements	Vicon	Hand/Finger Movements	LabView
Head Movements	Oculus Rift	Head Movements	Hard Drive
Neural Decode	MATLAB	Oculus Rift Video	Hard Drive
Task/Trial Information	LabView		

LabView Experiment Outline
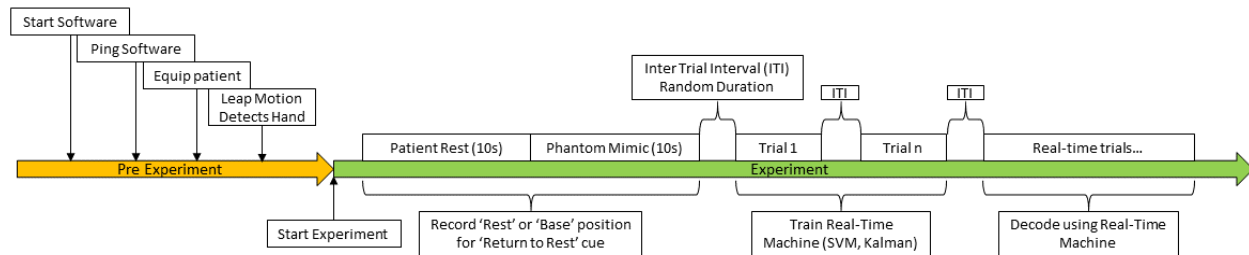
- Initialize and start accessory programs
  - Via PowerShell, start MATLAB, Unity, etc...
  - Ping software to ensure proper connections.
- Equip the patient with the Oculus Rift, Vicon stickers, and patient cable
- Ask the patient to move their arms until Leap Identifies their intact hand
- Ask patient to move to a rest position for 10 sec (record this base or rest position for 'Return to Rest' cue)
  - Ask patient to mimic phantom perceived positions with intact hand for 10 sec (record this base or rest position for 'Return to Rest' cue)
- Start Tasks
  - Which finger(s) or hand synergies
  - Which finger task (spherical or torus)
  - Save timestamps
  - Update Unity and MATLAB
  - **Trial Params/Information:**
    - Task Duration
    - Inter-task interval
    - **Sphere Task**
    - Finger(s) or synergies
    - Hold Time
    - Success Radius
    - Return to Rest cue
    - **Torus Task**
    - Finger
    - Success Radius
    - Rotation Number
    - Target (blue sphere)
    - Target Rotation Direction
    - Target Speed (Ramp on/Ramp off)
    - Cursor Position (Fingertip center)
    - Torus Color (Red or green based on the success radius)
    - Return to Rest cue
  - Save Streams
    - TimeStamps
    - Markers (success, failure, trial start, trial information/parameters)
    - Data Streams (Neural Decode, Finger Movements)

Task/Trial Summary

    Patient Rest

        Ask patient to be in a 'relaxed' or base position (Leap must be able to see all 5 fingers)

        - 10 seconds hold time

    Mimic Phantom Hand

        Ask patient to mimic the perceived position of their phantom hand with their intact hand

        - 10 seconds hold time

    Sphere Task

        Ask patient to move the indicated finger(s) or hand to the cued position

        - Red colored spheres will appear for the selected finger(s) and the patient must move their fingers to that position.

        - Spheres will become green when the patient's fingertip(s) are within some success radius of the sphere center(s).

        - Patients will be cued to return to a rest or base position (positions gathered from the Patient Rest task.

    Torus Task

        Ask patient to follow a blue target sphere around a torus

        - A red torus will appear around the selected finger.

        - A blue target sphere will appear on the torus.

        - Patient will move their finger to the blue target sphere.

        - Target sphere will start moving (clockwise or counter-clockwise), and will slowly ramp up speed.

        - Torus will change from red to green when the patient's finger is within some success radius of the blue target sphere.

        - The blue target sphere will rotate around the torus one or more times, at a set speed (with a ramp up and a ramp down).

        - The blue target sphere will appear at the same position each trial. The blue target sphere will also stop at that position.
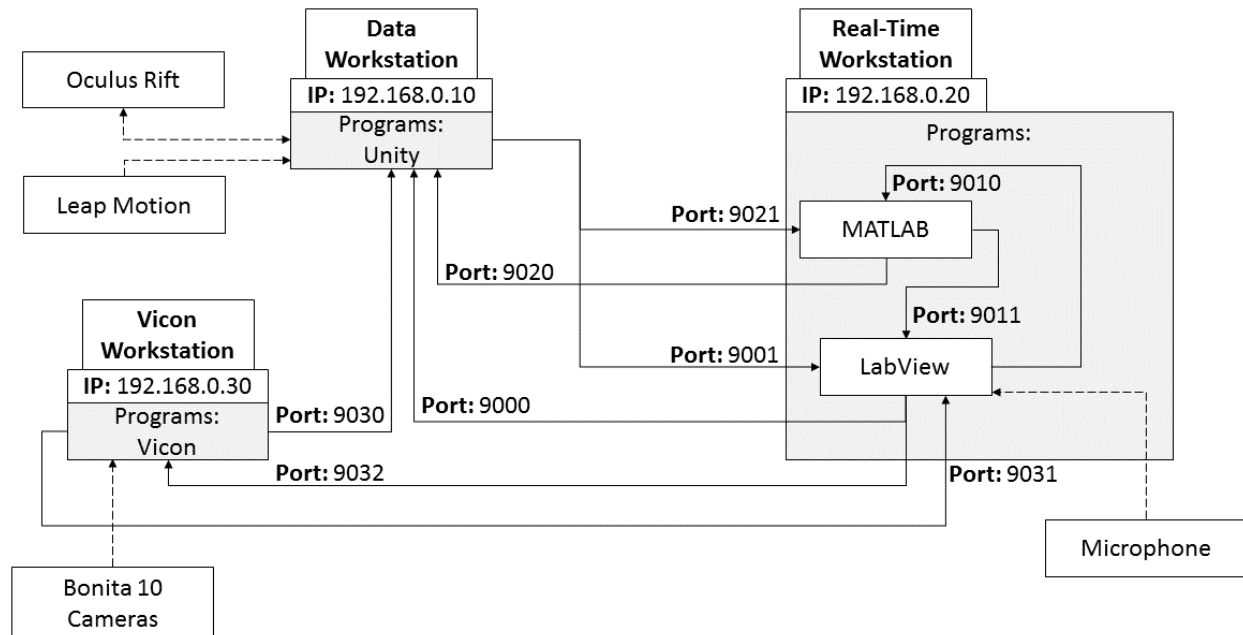
    Arm Task?

        Ask patient to move arms from resting on the table to held in the air

        - Perform the Sphere Task or Torus Task

    Wrist Task?

        Ask patient to move wrist at different angles

        - Perform the Sphere Task or Torus Task or Arm Task?

UDP Connection Scheme

Unity -> LabView
- Data: Hand positions
- IP: 192.198.0.20
- Port: 9001

LabView -> Unity
- Data: Target information
- IP: 192.198.0.10
- Port: 9000

MATLAB -> LabView
- Data: Neural Decode/Trained Matrix/Transfer Matrix/...
- IP: 127.0.0.1
- Port: 9011

LabView -> MATLAB
- Data: Task Information, Success information, (For training)
- IP: 127.0.0.1
- Port: 9010

Unity -> MATLAB
- Data: Hand Positions
- IP: 192.198.0.20
- Port: 9021

MATLAB -> Unity
- Data: Hand Positions
- IP: 192.198.0.10
- Port: 9020

Vicon -> LabView
- Data: Arm Positions
- IP: 192.198.0.20
- Port: 9031

Vicon -> Unity
- Data: Hand Positions
- IP: 192.198.0.20
- Port: 9030

LabView -> Vicon
- Data: ???
- IP: 192.198.0.30
- Port: 9032

Packet Construction

    LabView -> Unity
      Single Finger Trial Example
        Trial Start:
        'T:0;D:0;'
        - Trial: 0 (Sphere); Display: 0 (off);

        Trial Cue:
        'F:0;Q:[s,i,j,k][s,i,j,k][s,i,j,k];C:R;'
        - Finger: 0 (Thumb); Quaternion: [s,i,j,k][s,i,j,k][s,i,j,k]; Color: Red;

        Display Trial:
        'F:0;D:1;'
        - Display: 1 (on);

        Success Visual:
        'F:0;C:G;'
        - Finger: 0 (Thumb); Color: Green;

        Return to Rest Cue:
        'F:0;Q:[s,i,j,k][s,i,j,k][s,i,j,k];C:R;'
        - Finger: 0 (Thumb); Quaternion: [s,i,j,k][s,i,j,k][s,i,j,k]; Color: Red;

        Display Trial:
        'D:0;'
        - Display: 0 (off);

      Multi Finger Trial Example

        Trial Start:
        'T:0;D:0;'
        - Trial: 0 (Sphere); Display: 0 (off);

        Trial Cue
        'F:012;Q:[s,i,j,k][s,i,j,k][s,i,j,k][s,i,j,k][s,i,j,k][s,i,j,k][s,i,j,k][s,i,j,k][s,i,j,k];C:RRR;'
        - Finger: 0,1,2 (Thumb, Index, Middle); Quaternion: [s,i,j,k][s,i,j,k][s,i,j,k] (First
Finger), [s,i,j,k][s,i,j,k][s,i,j,k] (Second Finger), [s,i,j,k][s,i,j,k][s,i,j,k] (Third Finger); Color: Red, Red, Red;

        Display Trial:
        'D:1;'
        - Display: 1 (on);

        Partial Success Visual
        'F:01;C:GG;'
        'F:2;C:G;'

Return to Rest Cue
'F:012;Q:[s,i,j,k][s,i,j,k][s,i,j,k][s,i,j,k][s,i,j,k][s,i,j,k][s,i,j,k][s,i,j,k][s,i,j,k];C:RRR;'

Display Trial:
'D:0;'
- Display: 0 (off);

Torus Task Example

Trial Start:
'T:1;D:0;'
- Trial: 1 (Torus); Display: 0 (off);

Trial Cue:
'F:1;Q:[s,i,j,k][s,i,j,k][s,i,j,k];C:R;'
- Finger: 1 (Index); Quaternion: [s,i,j,k][s,i,j,k][s,i,j,k]; Color: Red;

Display Trial:
'D:1;'
- Display: 1 (on);

Success Visual:
'F:0;C:G;'
- Finger: 1 (Index); Color: Green;

Return to Rest Cue:
'F:0;Q:[s,i,j,k][s,i,j,k][s,i,j,k];C:R;'
- Finger: 1 (Index); Quaternion: [s,i,j,k][s,i,j,k][s,i,j,k]; Color: Red;

Display Trial:
'D:0;'
- Display: 0 (off);

Unity -> LabView/MATLAB
Hand/Finger Positions
'F:012345;Q:[s,i,j,k][s,i,j,k][s,i,j,k];'