Contactless Interfacing with DICOM using Leap Motion

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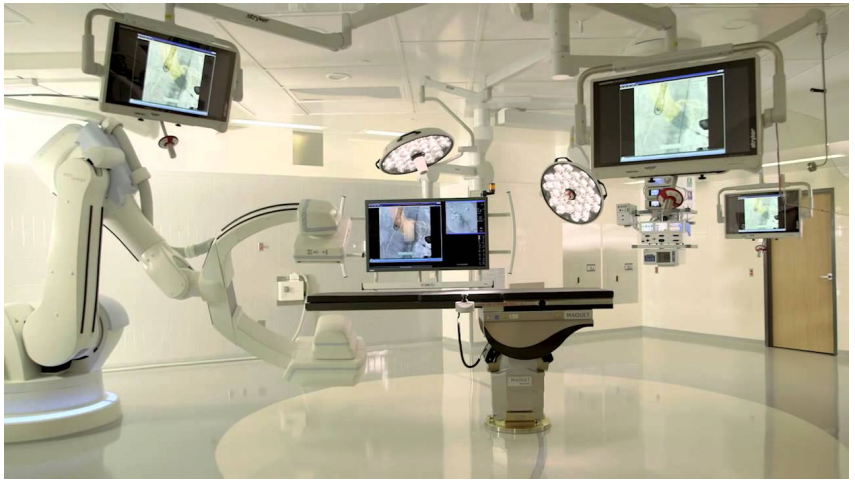
Problem

- Operating Room is a Sterile Environment.
- Sterilizing a Surgeon's Hands Takes Time.
- Large Collection of 2D and 3D Scans.
- Mice cannot be Sterilized Fully.



1 Problem

2 DICOM Viewers

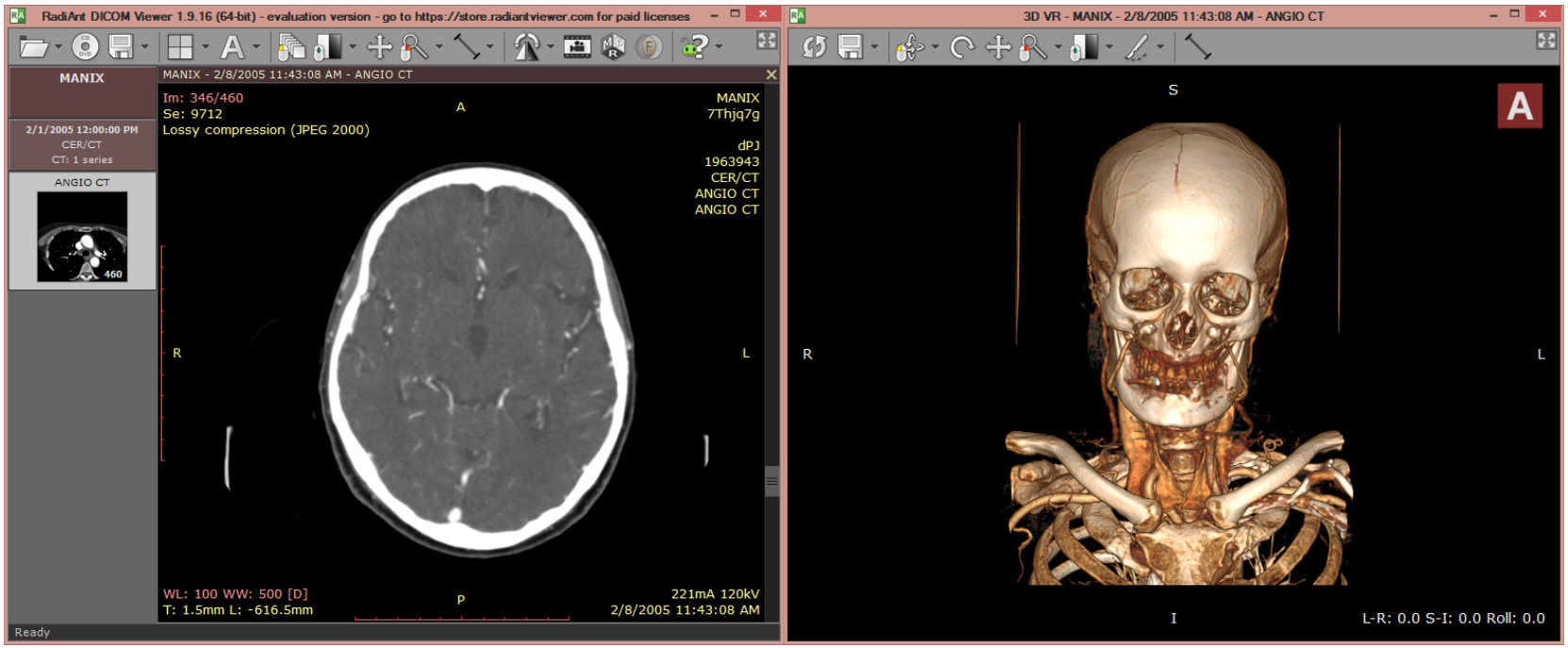
3 Leap Motion

4 Protocol Design

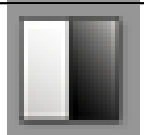
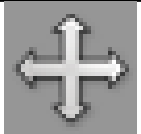
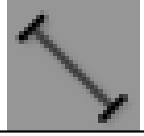
5 Gesture Recognition

6 Testing and Discussion

RadiAnt


RadiAnt DICOM Viewer 1.9.16 (64-bit) - evaluation version - go to https://store.radiantviewer.com for paid licenses
MANIX
2/1/2005 12:00:00 PM
CER/CT
CT: 1 series
ANGIO CT
460
MANIX - 2/8/2005 11:43:08 AM - ANGIO CT
Im: 346/460
Se: 9712
Lossy compression (JPEG 2000)
A
MANIX
7Thjq7g
dPJ
1963943
CER/CT
ANGIO CT
ANGIO CT
R
L
P
WL: 100 WW: 500 [D]
T: 1.5mm L: -616.5mm
221mA 120kV
2/8/2005 11:43:08 AM
Ready
3D VR - MANIX - 2/8/2005 11:43:08 AM - ANGIO CT
S
A
R
L
I
L-R: 0.0 S-I: 0.0 Roll: 0.0

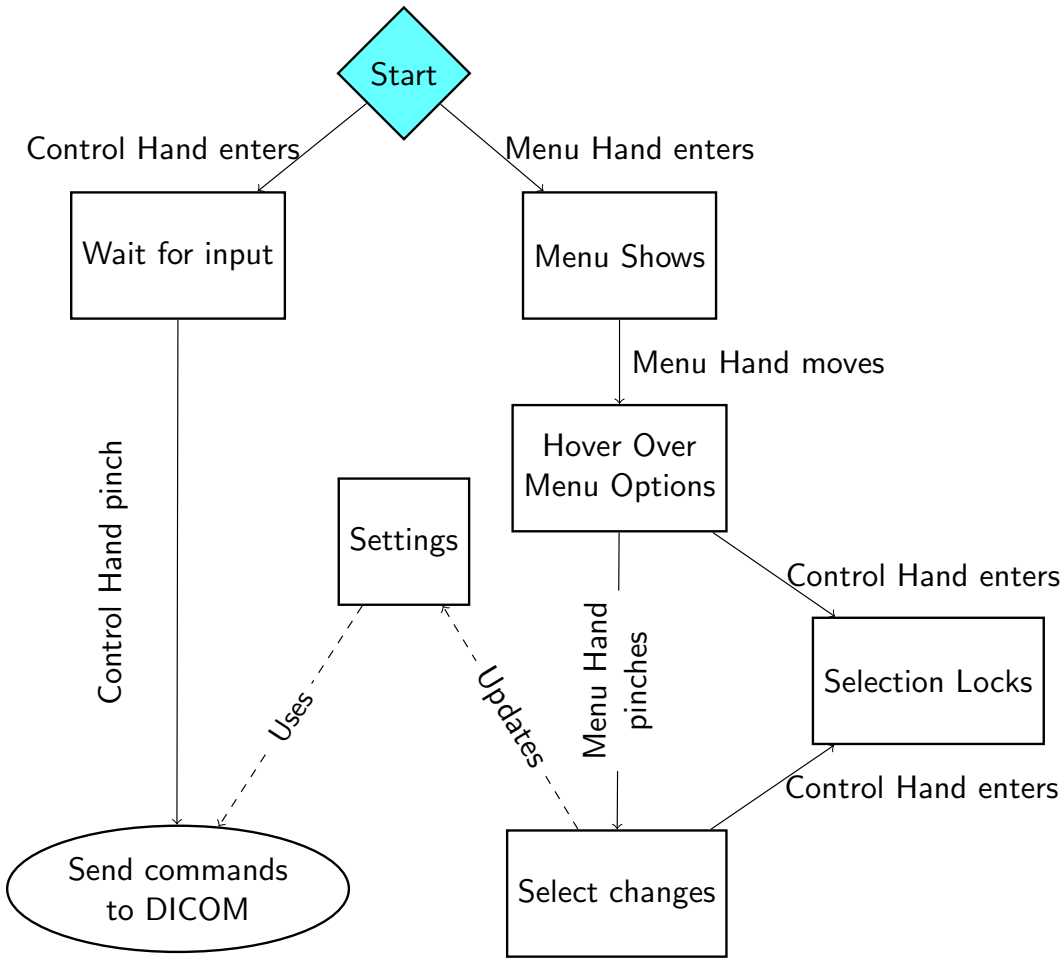
DICOM Interaction Modes

Modes	Icon	Default Mouse Button	Key Combo
Layer		Left Mouse Button	B
Brightness/Contrast		Middle Click	W
Pan		Shift + Left Mouse Button	M
Zoom		Right Mouse Button	Z
Measure (Length)		N/A	L

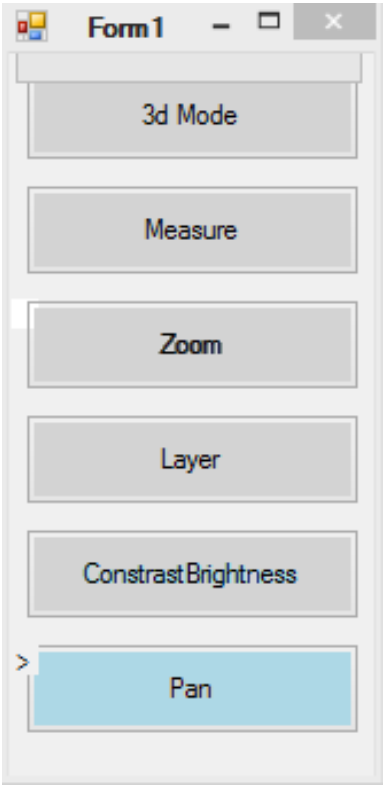
Leap Motion Bone Structure

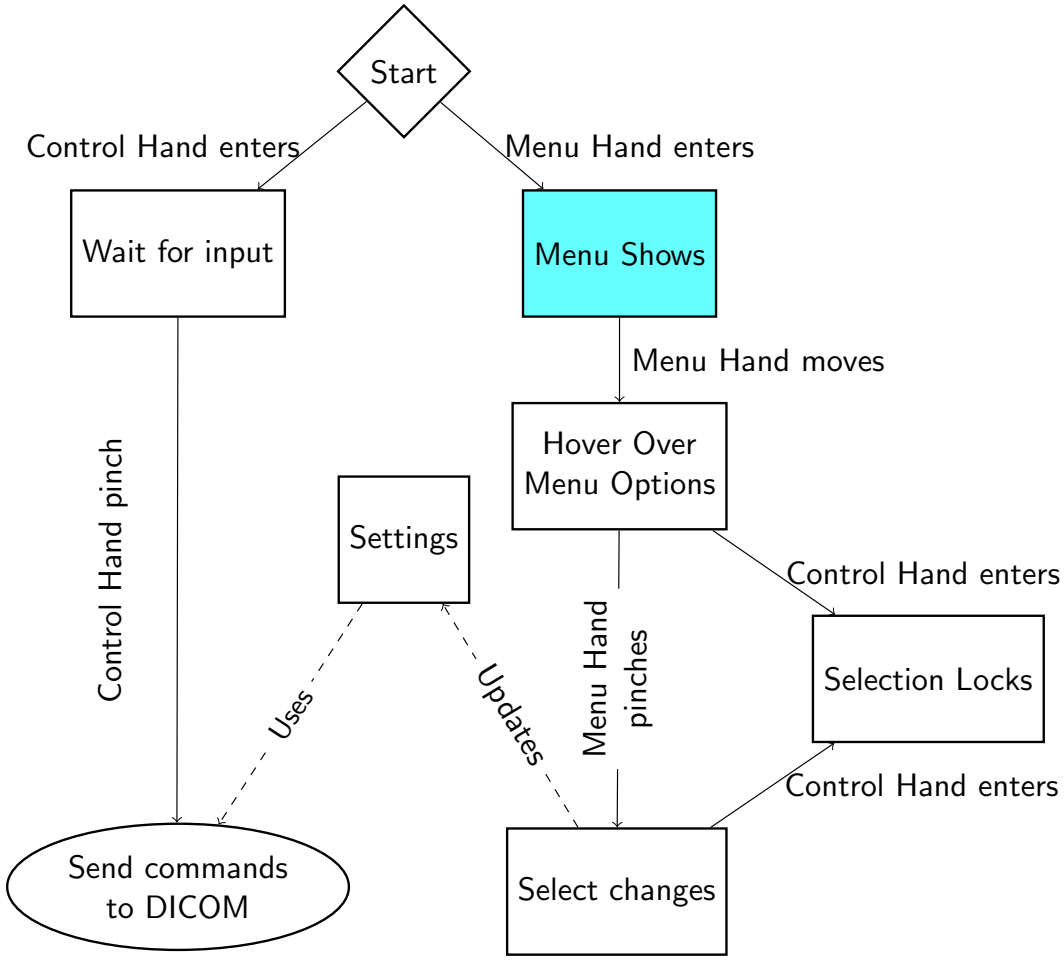
- Provides Hand Tracking at 30-115 *Frame*s per Second.
- Two Inferred Stereoscopic Cameras
- Provides SDK in C#
- $80 Consumer Device

Program Flow

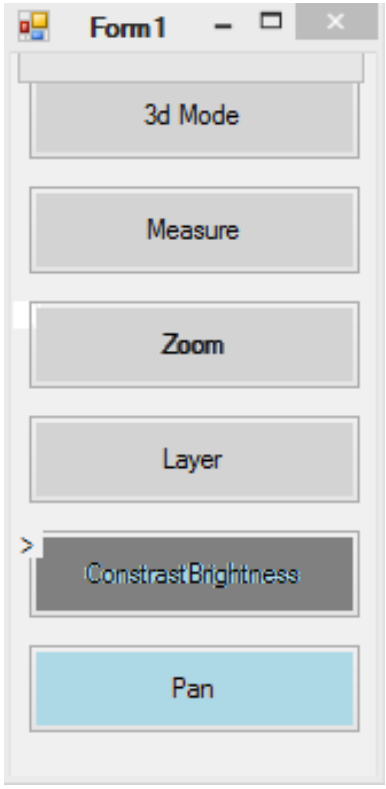


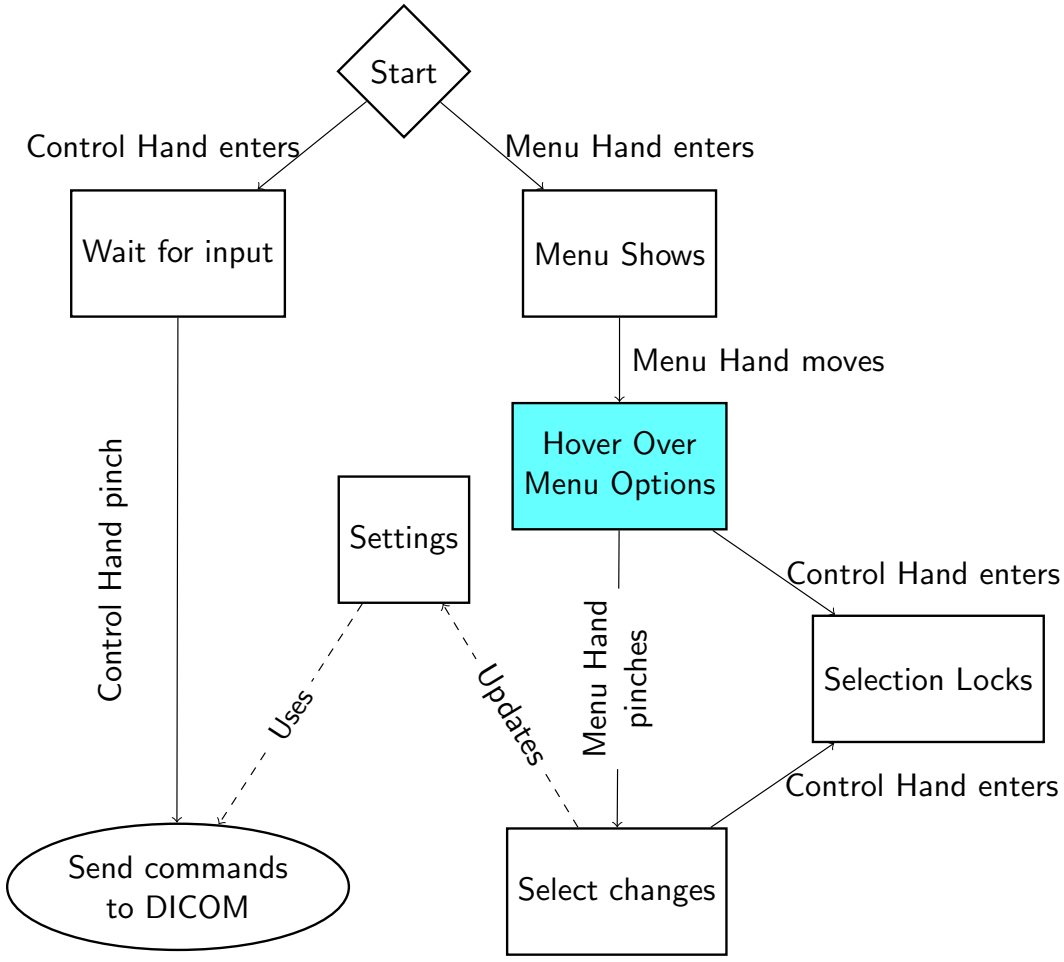
Program Flow



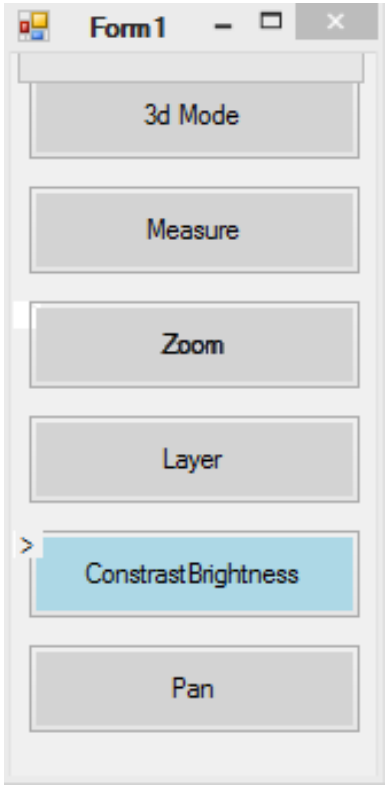


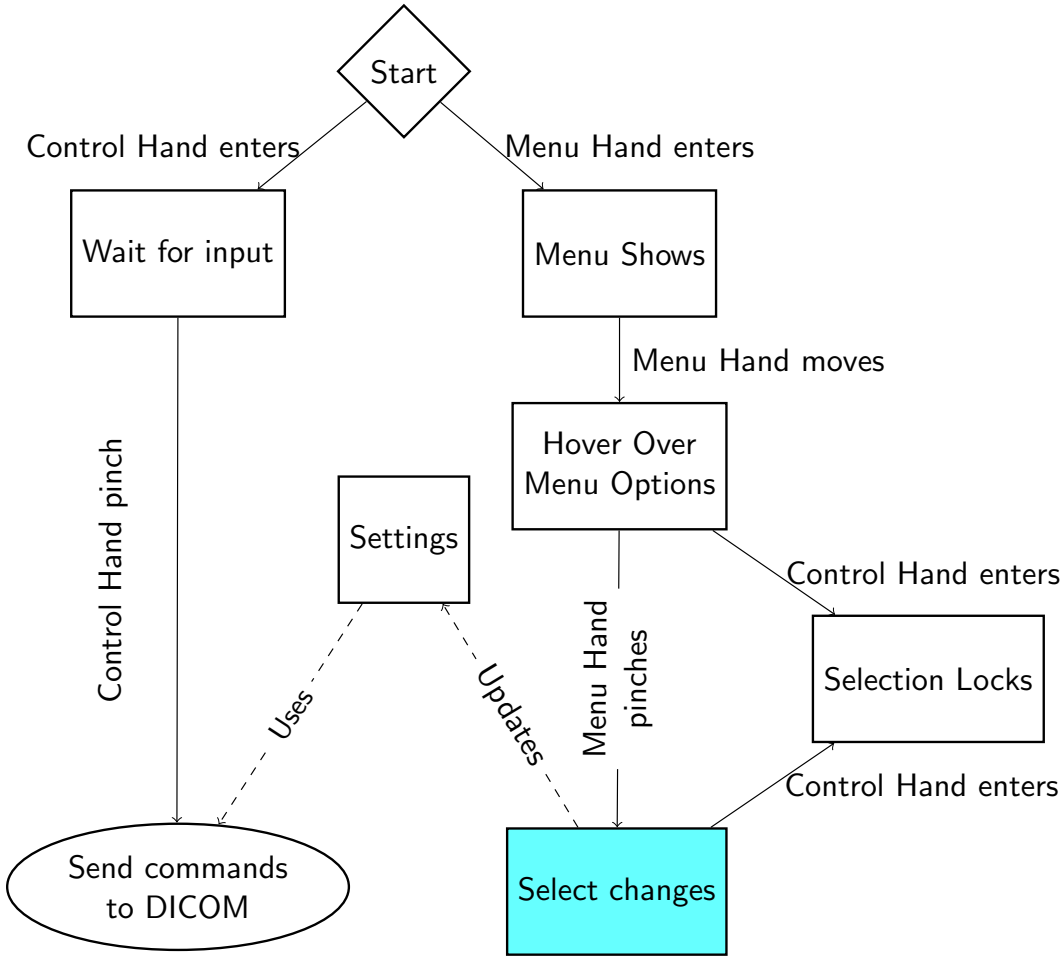
Program Flow



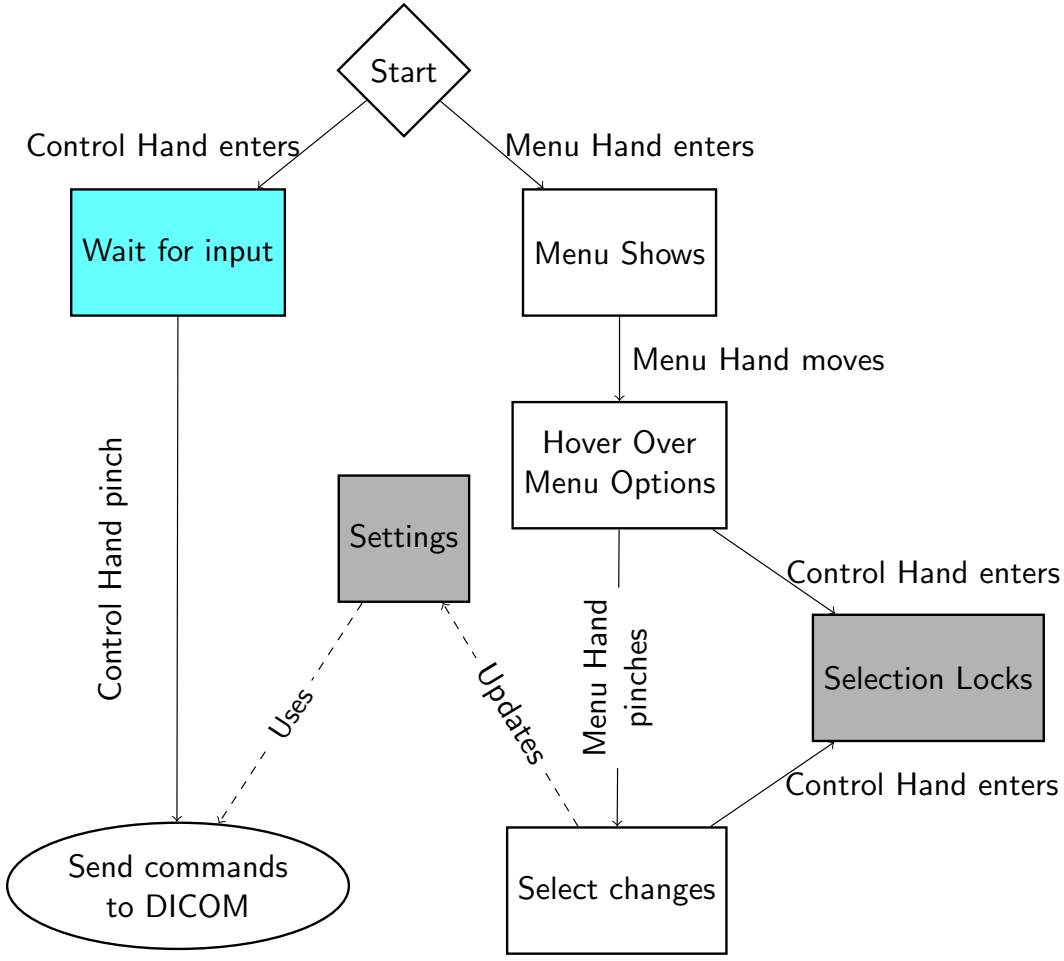


Program Flow

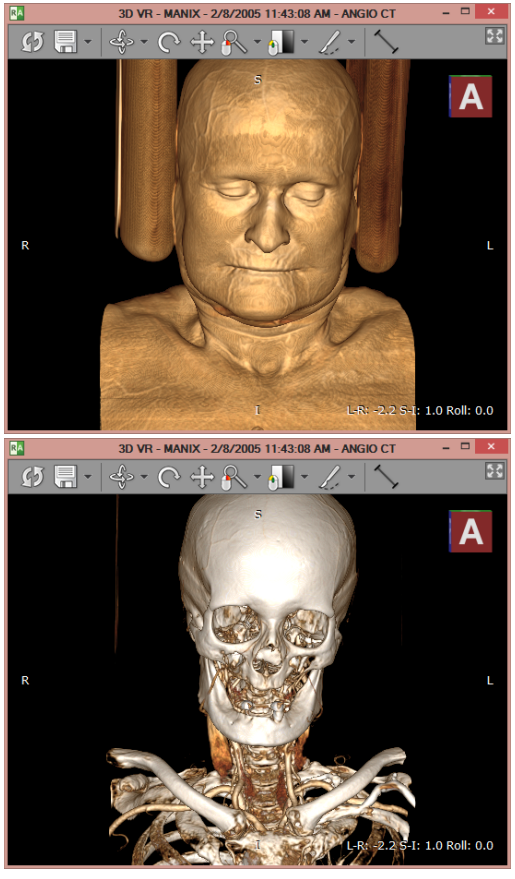


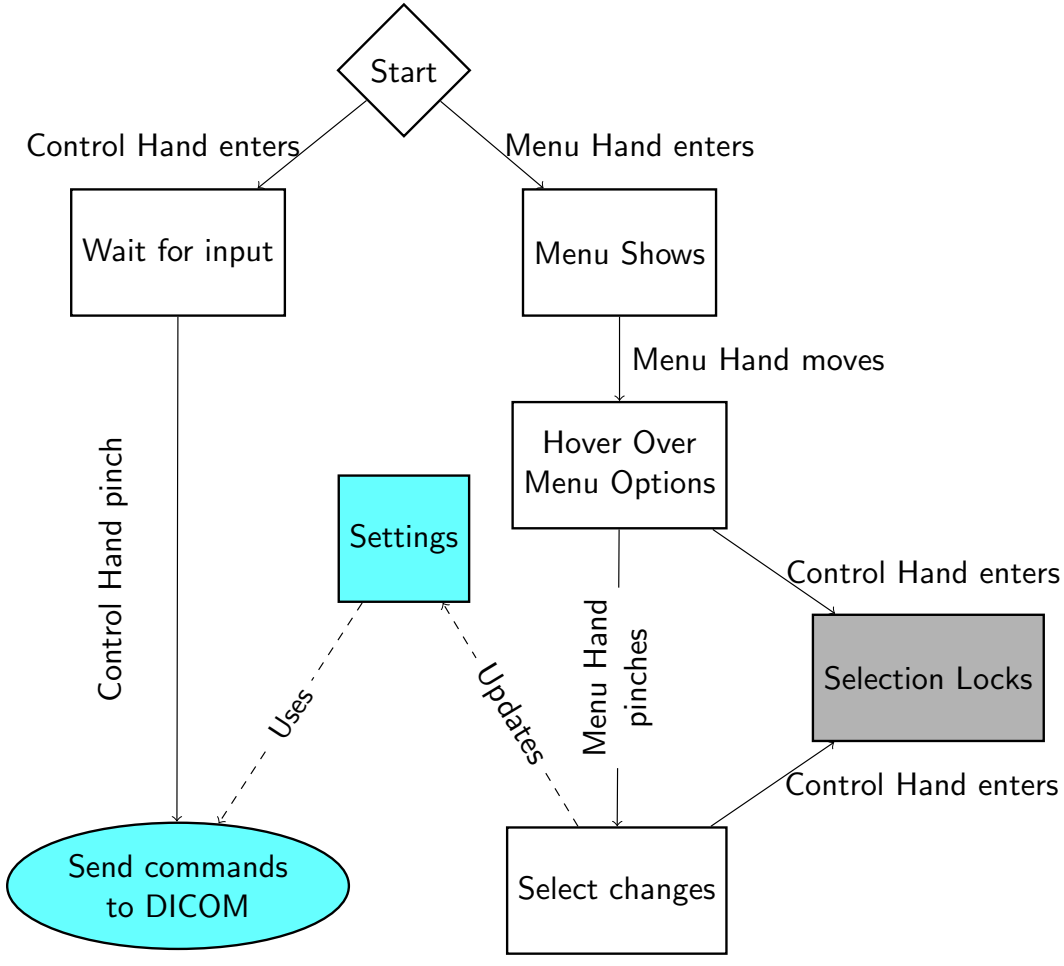


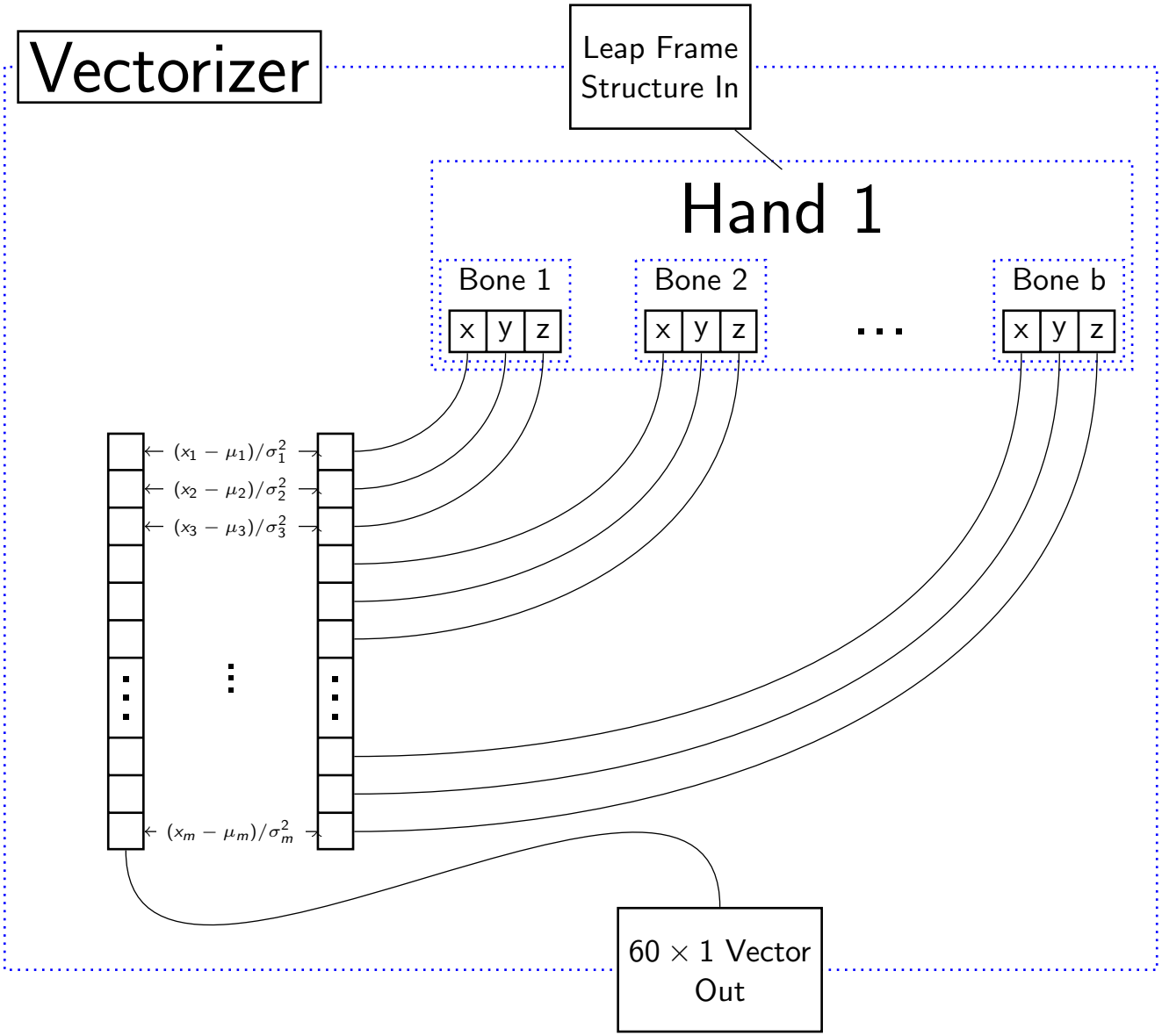
Program Flow

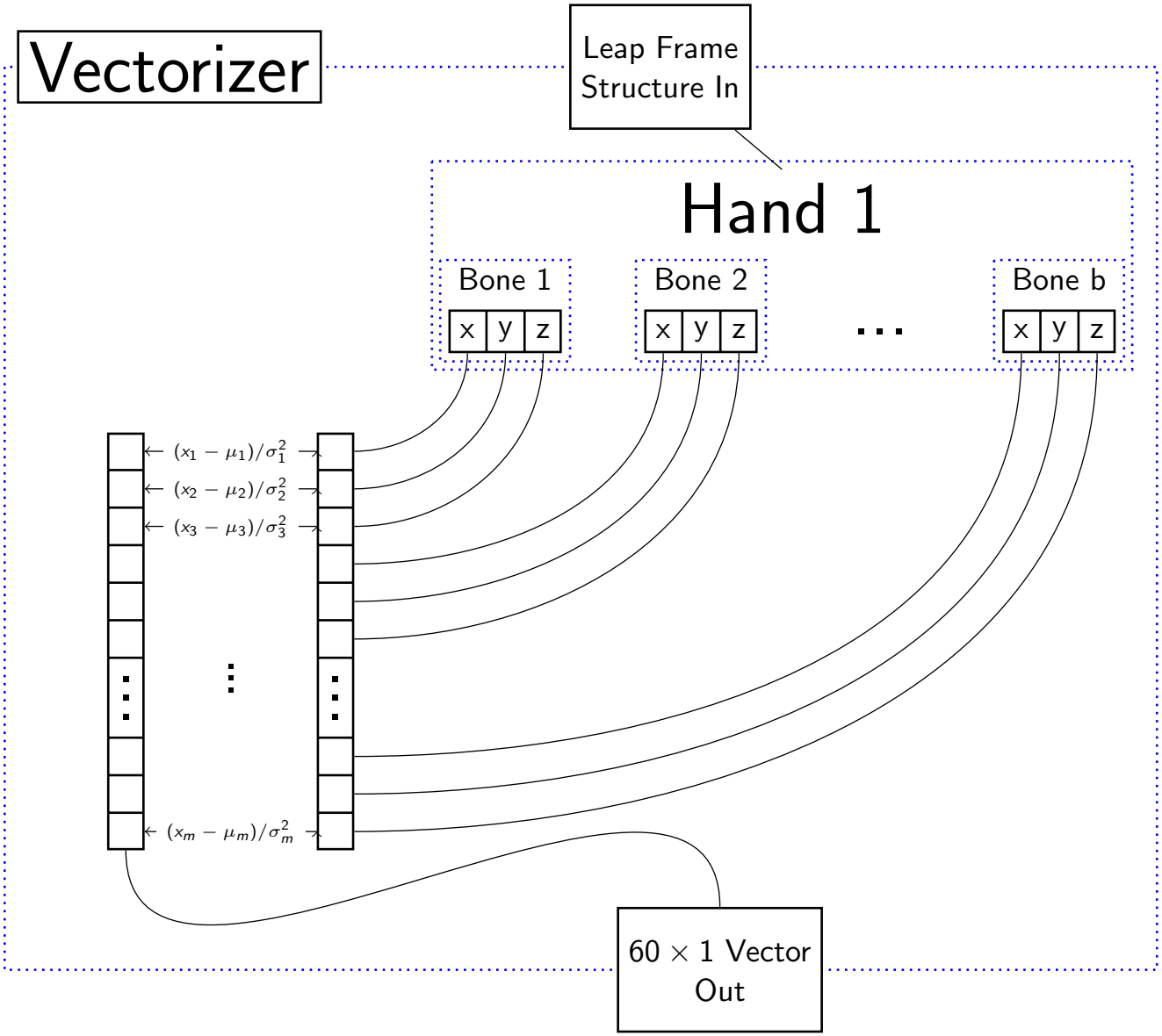


Program Flow






Vectorizer
Leap Frame Structure In
Hand 1
Bone 1
Bone 2
Bone b
x y z
x y z
x y z
$(x_1 - \mu_1)/\sigma_1^2$
$(x_2 - \mu_2)/\sigma_2^2$
$(x_3 - \mu_3)/\sigma_3^2$
$(x_m - \mu_m)/\sigma_m^2$
60 × 1 Vector Out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Leap Frame Structure In
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Bone 1
Bone 2
Bone b
x y z
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$(x_1 - \mu_1)/\sigma_1^2$
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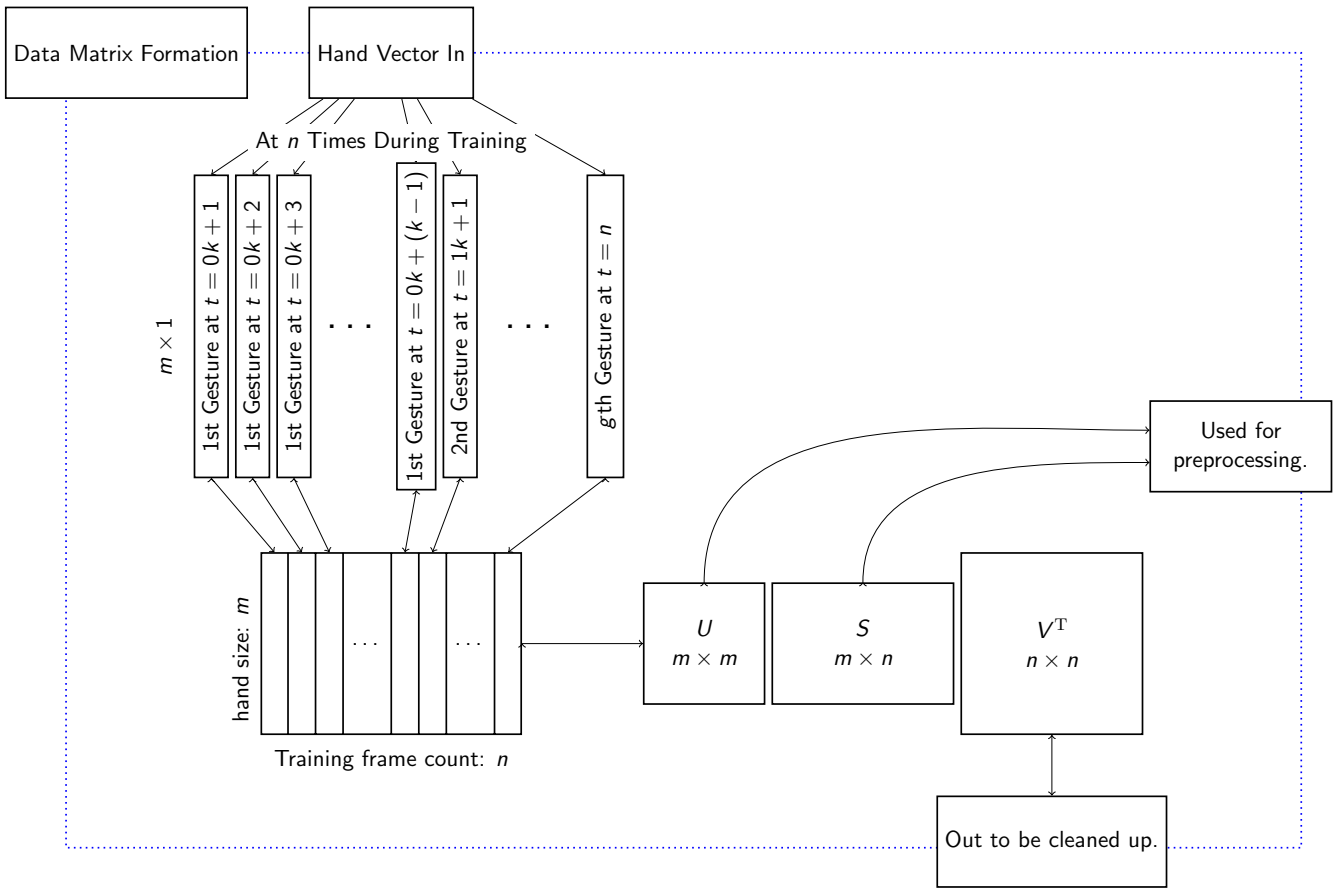
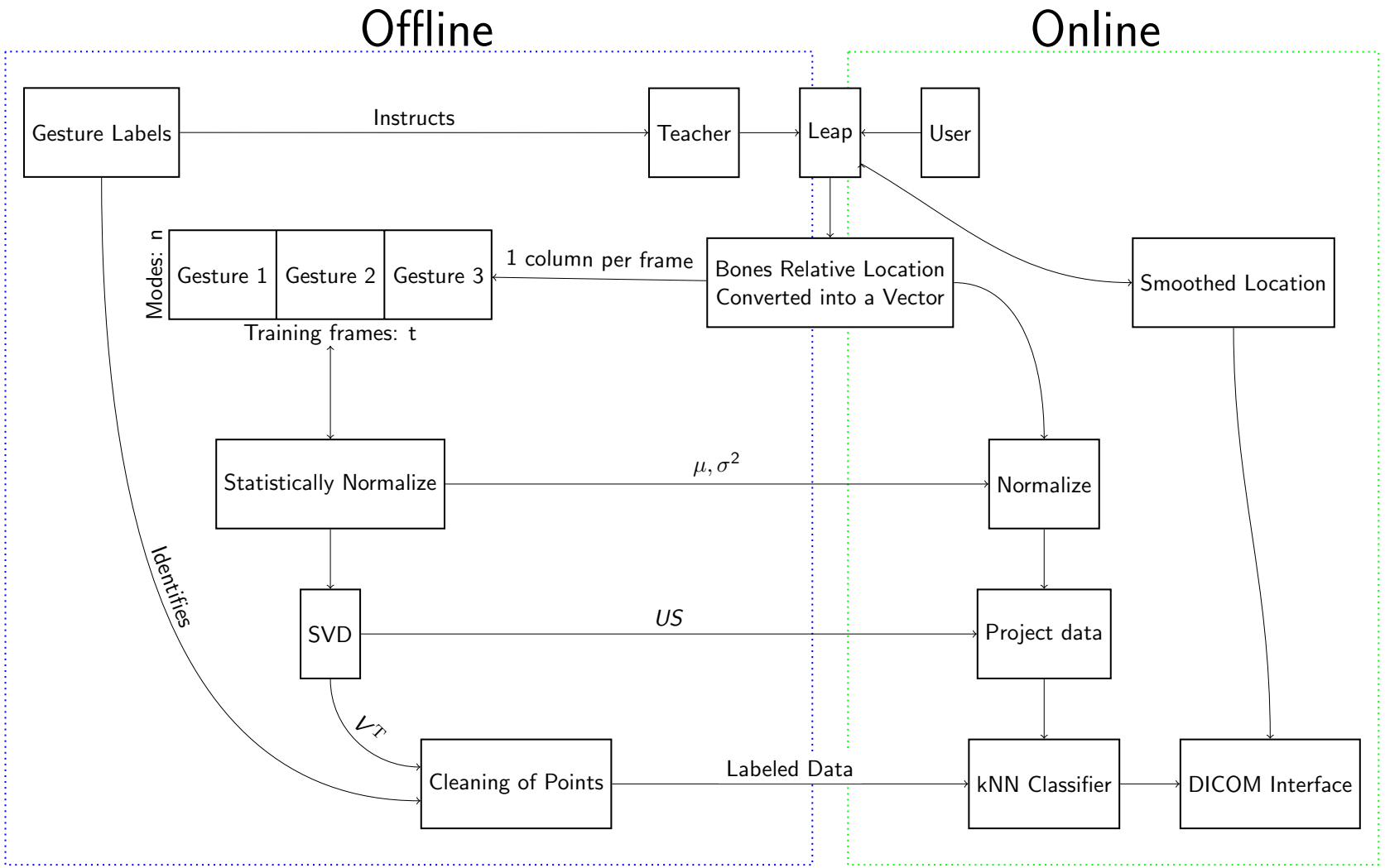
$(x_m - \mu_m)/\sigma_m^2$
60 × 1 Vector Out

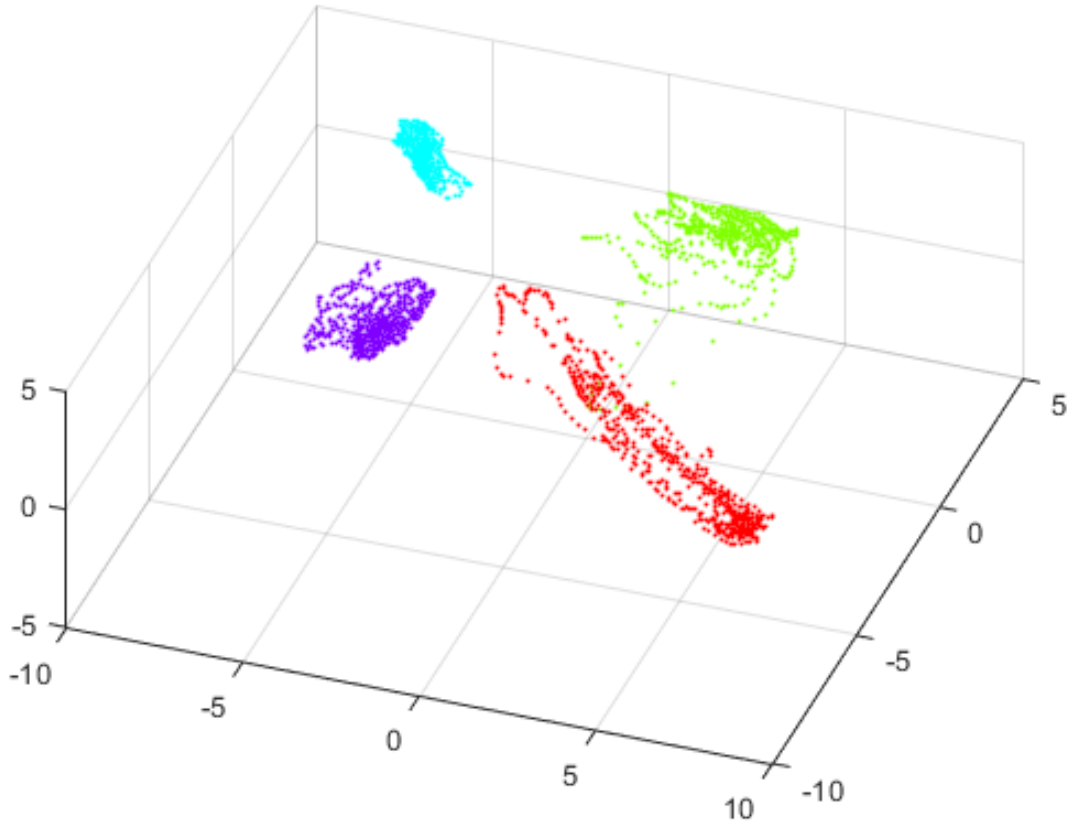

Data Matrix Formation
Hand Vector In
At n Times During Training
$m \times 1$
1st Gesture at $t = 0k + 1$
1st Gesture at $t = 0k + 2$
1st Gesture at $t = 0k + 3$
1st Gesture at $t = 0k + (k - 1)$
2nd Gesture at $t = 1k + 1$
gth Gesture at $t = n$
hand size: m
Training frame count: n
U
$m \times m$
S
$m \times n$
V^{T}
$n \times n$
Used for preprocessing.
Out to be cleaned up.


Offline
Online
Gesture Labels
Instructs
Teacher
Leap
User
Modes: n
Gesture 1
Gesture 2
Gesture 3
Training frames: t
1 column per frame
Bones Relative Location
Converted into a Vector
Smoothed Location
Statistically Normalize
μ, σ^2
Normalize
Identifies
SVD
US
Project data
V_T
Cleaning of Points
Labeled Data
kNN Classifier
DICOM Interface

Eigen Vectors as Hands

Mode	Negative	Positive	Description
First			General Tightness
Second			Thumb and Pointer Move in and out Together
Third			Thumb and Pointer Move in and out Alternating

V plotted as a scatter plot.



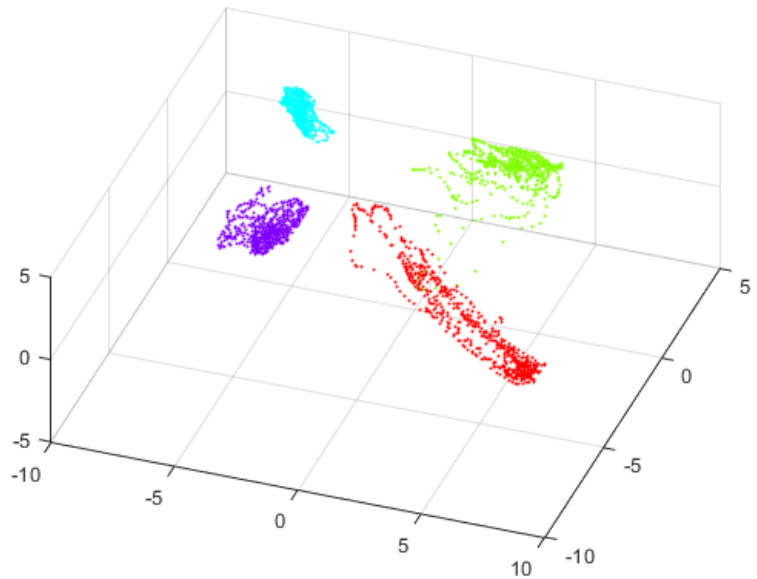
First 3 Columns of V, Gesture Templates in the US basis.

Gestures and their coordinates in V

Gesture	Example	Bone View	1	2	3
1			5.14	-5.16	0.80
2			2.60	2.90	1.12
3			-5.52	1.89	3.55
4			-5.99	0.11	-1.98

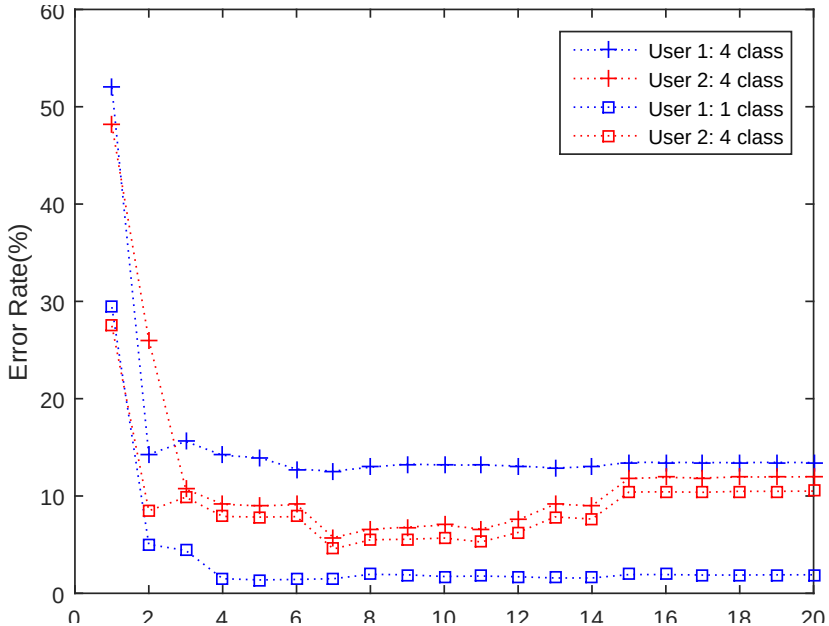
Gestures and their coordinates in V

Gesture	1	2	3
	5.14	-5.16	0.80
	2.60	2.90	1.12
	-5.52	1.89	3.55
	-5.99	0.11	-1.98



Recognition Times with Gloves

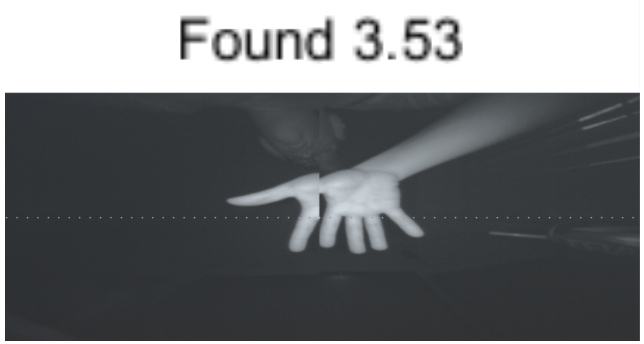
- User 1 Trains the System with 4000 points.
  - All Used to Find $\mu, \sigma, X = USV^{\mathrm{T}}$
  - 400 Used a Gesture Templates.
- User 1 & 2 Generating 4000 Points Using Stored μ, σ, US.
- kNN Used on this New Data and Stored Templates

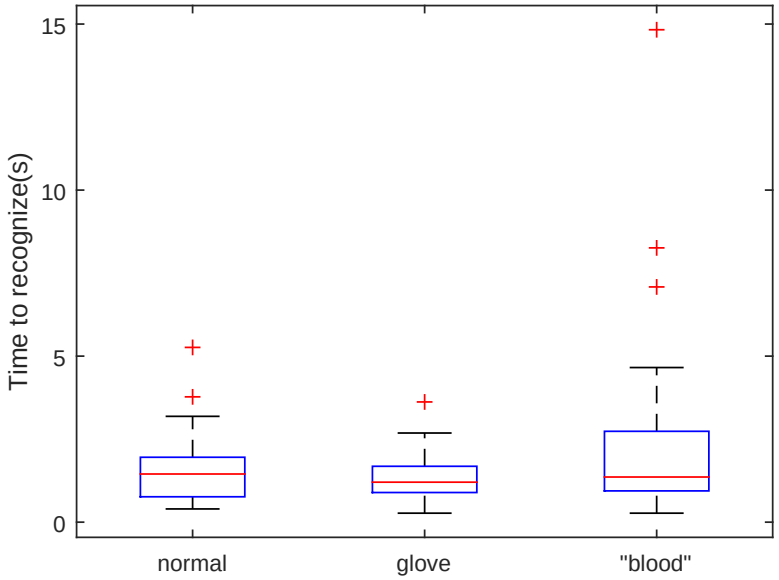


Subject	4 class	1 vs all
User 1	87.44%	98.5%
User 2	94.27%	95.45%

Recognition Times with Gloves

- Timing Done with a Tool Written in Unity.
- Uses Leap Motions IR Image and Hand Count.
- Test Center Row's Brightest Pixel to Start a Timer.
- Uses Hand Count to Stop Timer.
- 30 Runs per Setup.





Goto Video

Goto video now.