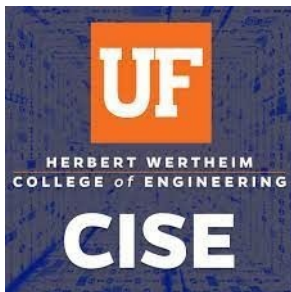


iPrep AI



Ira Harmon

Daisy Zhe Wang



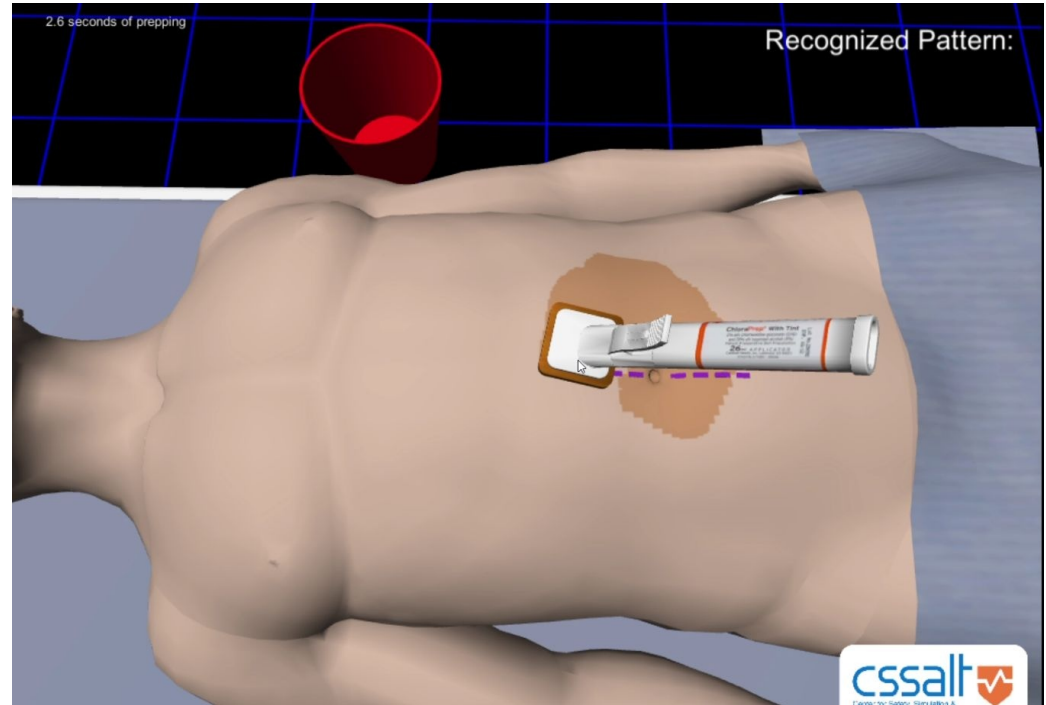
David Lizdas

Samsun Lampotang

iPrep

iPrep is a computer simulation used to teach pre-procedure preparation including

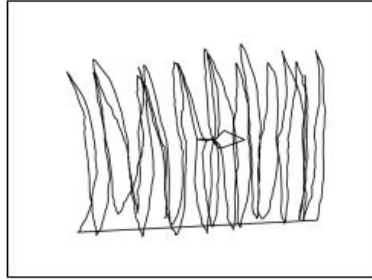
- antiseptic application
- antiseptic drying time
- draping



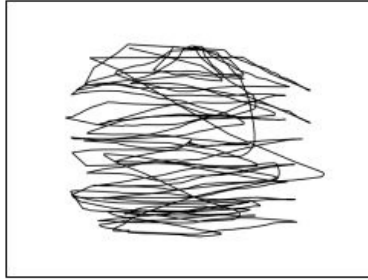
Goal

- Recognize antiseptic application techniques
- Apply image pattern recognition over simulation data
- Classes
 - 1) Up-down
 - 2) Back-forth
 - 3) Up-down-back-forth
 - 4) Simple-spiral
 - 5) Modified-spiral
 - 6) Other

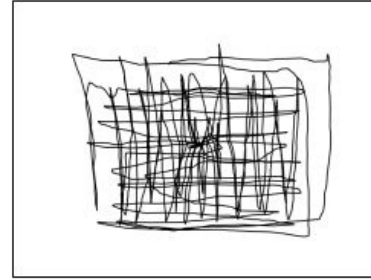
Example Swab Patterns



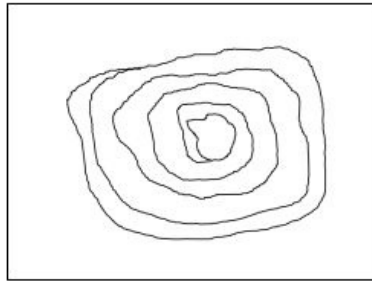
Up-down



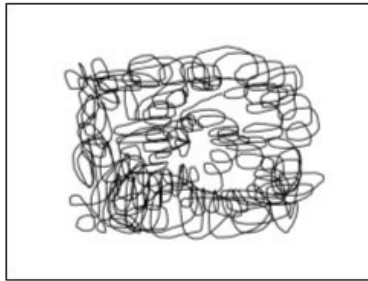
Back-forth



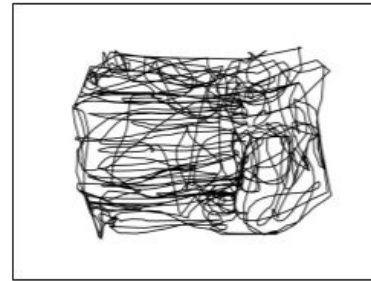
Up-down-back-forth



Simple spiral



Modified spiral



Other

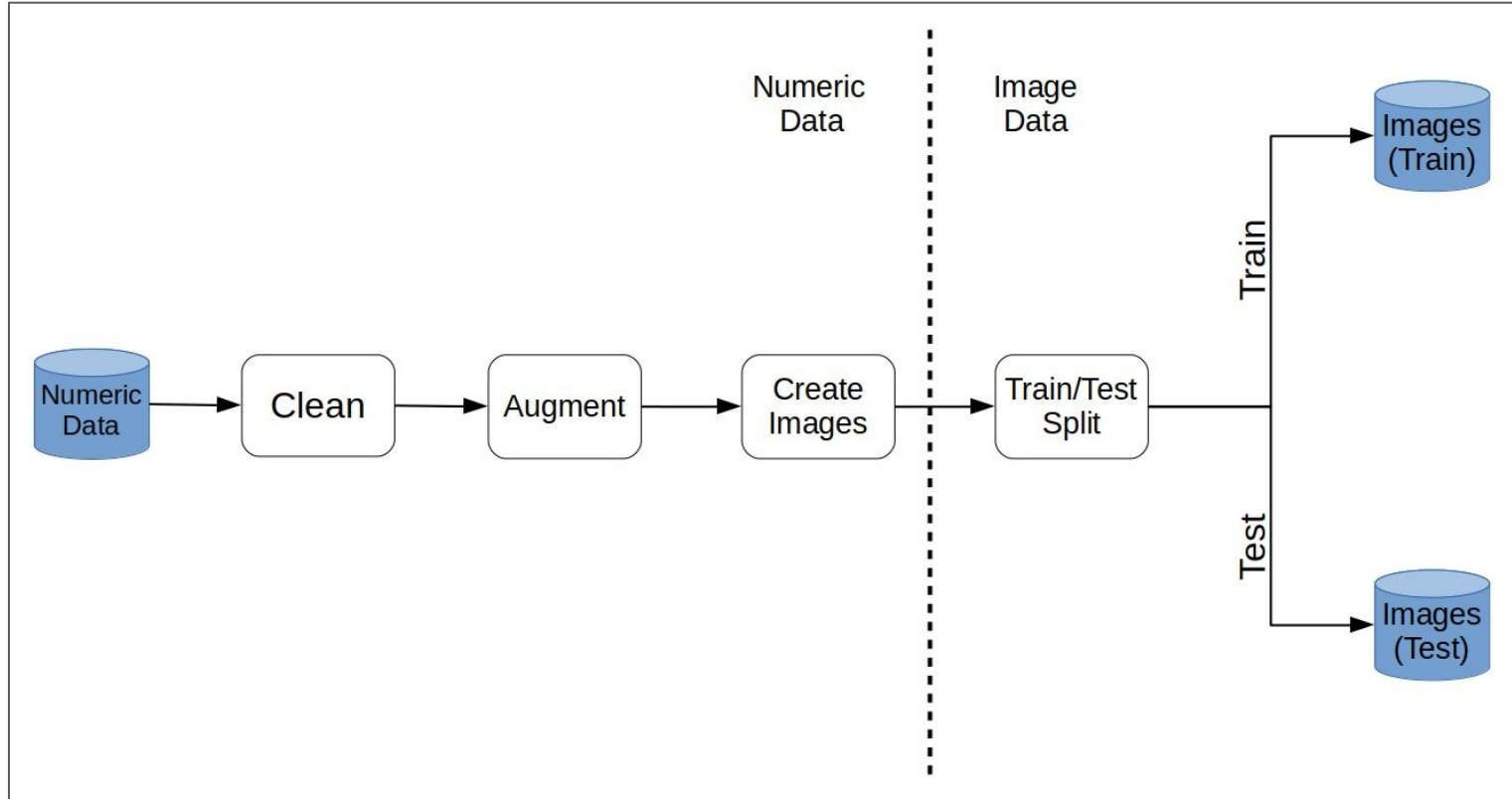
Experiment 1 Dataset

Designed to detect patterns at the end of the prep/simulation

- 288 instances
 - Train: 201
 - Test: 87
 - Length: 0 - 57 s
 - 640 x 480 x 3 images

 - Transforms
 - Flip-x
 - Flip-y
 - Flip-x-y
 - Add Gaussian Noise
 - Flip-x-y & Add Noise

Data Processing Pipeline



Model

- ResNet18
 - Convolutional Neural Network
 - 11 million trainable parameters
 - Pre-trained on ImageNet
 - Trained for 5 epochs with stochastic gradient descent

Model

layer name	output size	18-layer	34-layer	50-layer	101-layer	152-layer
conv1	112×112	7×7, 64, stride 2				
conv2_x	56×56	3×3 max pool, stride 2				
		$\begin{bmatrix} 3\times 3, 64 \\ 3\times 3, 64 \end{bmatrix} \times 2$	$\begin{bmatrix} 3\times 3, 64 \\ 3\times 3, 64 \end{bmatrix} \times 3$	$\begin{bmatrix} 1\times 1, 64 \\ 3\times 3, 64 \\ 1\times 1, 256 \end{bmatrix} \times 3$	$\begin{bmatrix} 1\times 1, 64 \\ 3\times 3, 64 \\ 1\times 1, 256 \end{bmatrix} \times 3$	$\begin{bmatrix} 1\times 1, 64 \\ 3\times 3, 64 \\ 1\times 1, 256 \end{bmatrix} \times 3$
conv3_x	28×28	$\begin{bmatrix} 3\times 3, 128 \\ 3\times 3, 128 \end{bmatrix} \times 2$	$\begin{bmatrix} 3\times 3, 128 \\ 3\times 3, 128 \end{bmatrix} \times 4$	$\begin{bmatrix} 1\times 1, 128 \\ 3\times 3, 128 \\ 1\times 1, 512 \end{bmatrix} \times 4$	$\begin{bmatrix} 1\times 1, 128 \\ 3\times 3, 128 \\ 1\times 1, 512 \end{bmatrix} \times 4$	$\begin{bmatrix} 1\times 1, 128 \\ 3\times 3, 128 \\ 1\times 1, 512 \end{bmatrix} \times 8$
conv4_x	14×14	$\begin{bmatrix} 3\times 3, 256 \\ 3\times 3, 256 \end{bmatrix} \times 2$	$\begin{bmatrix} 3\times 3, 256 \\ 3\times 3, 256 \end{bmatrix} \times 6$	$\begin{bmatrix} 1\times 1, 256 \\ 3\times 3, 256 \\ 1\times 1, 1024 \end{bmatrix} \times 6$	$\begin{bmatrix} 1\times 1, 256 \\ 3\times 3, 256 \\ 1\times 1, 1024 \end{bmatrix} \times 23$	$\begin{bmatrix} 1\times 1, 256 \\ 3\times 3, 256 \\ 1\times 1, 1024 \end{bmatrix} \times 36$
conv5_x	7×7	$\begin{bmatrix} 3\times 3, 512 \\ 3\times 3, 512 \end{bmatrix} \times 2$	$\begin{bmatrix} 3\times 3, 512 \\ 3\times 3, 512 \end{bmatrix} \times 3$	$\begin{bmatrix} 1\times 1, 512 \\ 3\times 3, 512 \\ 1\times 1, 2048 \end{bmatrix} \times 3$	$\begin{bmatrix} 1\times 1, 512 \\ 3\times 3, 512 \\ 1\times 1, 2048 \end{bmatrix} \times 3$	$\begin{bmatrix} 1\times 1, 512 \\ 3\times 3, 512 \\ 1\times 1, 2048 \end{bmatrix} \times 3$
	1×1	average pool, 1000-d fc, softmax				
FLOPs		1.8×10^9	3.6×10^9	3.8×10^9	7.6×10^9	11.3×10^9

Experiment 1 Results

	precision	recall	f1-score	support
up_down	1.00	1.00	1.00	9
up_down_back_forth	1.00	1.00	1.00	11
other	0.88	1.00	0.93	21
mod_spiral	1.00	0.82	0.90	17
sim_spiral	1.00	1.00	1.00	24
back_forth	1.00	1.00	1.00	5
accuracy			0.97	87
macro avg	0.98	0.97	0.97	87
weighted avg	0.97	0.97	0.96	87

Test run-time: 18.89s / 87 instances \approx 0.22 s per instance

Experiment 2 Dataset

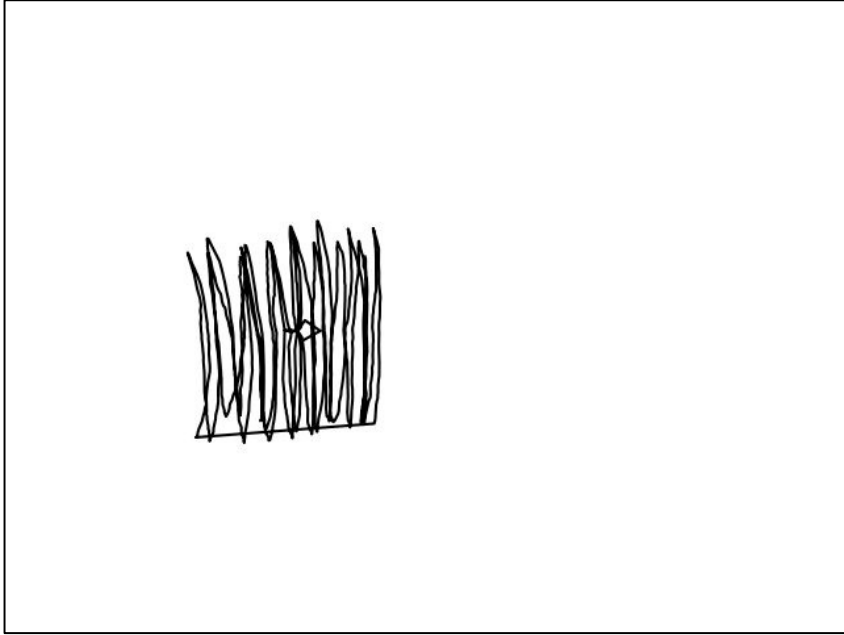
Designed to detect patterns in real-time in 10s increments

Dataset 1092 instances

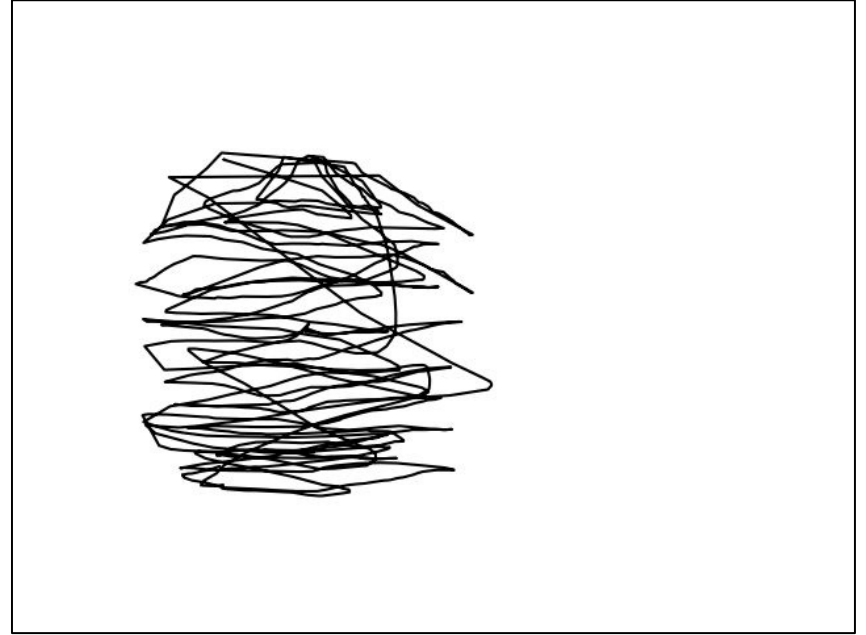
- Train: 764
- Test: 328
- Length: 0 - 57 s
- 640 x 480 x 3 images

- Transforms
 - Flip-x
 - Flip-y
 - Flip-x-y
 - Add Gaussian Noise
 - Flip-x-y & Add Noise
 - Fragment (1 - 10 s)

Example Image Fragments



Up-Down



Back-Forth

Experiment 2: Partial Image Classification Model

Difference in Dataset

- Images displayed within canvas of fixed size
- Fixed canvas helps partial image classification

Model

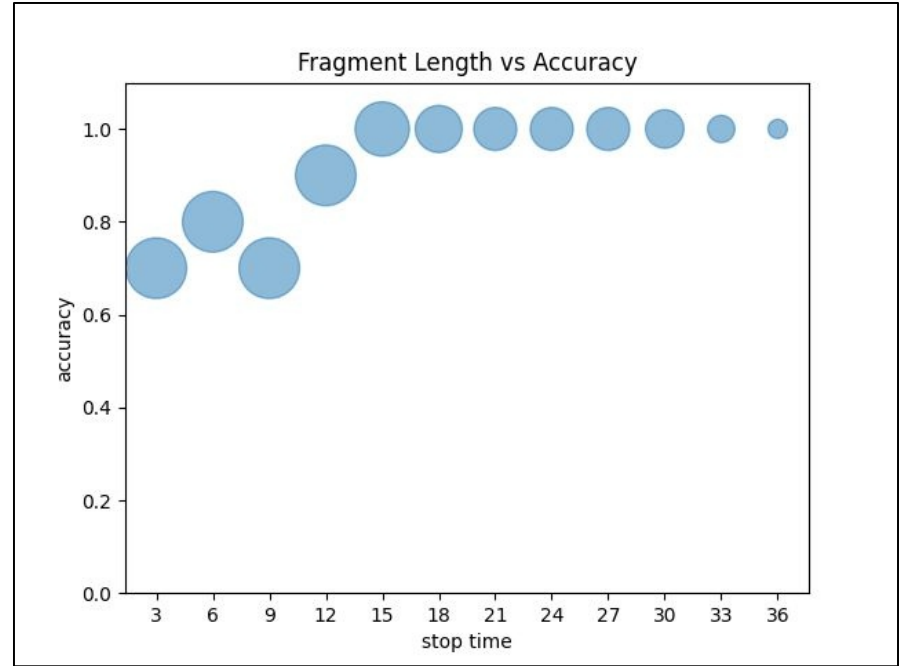
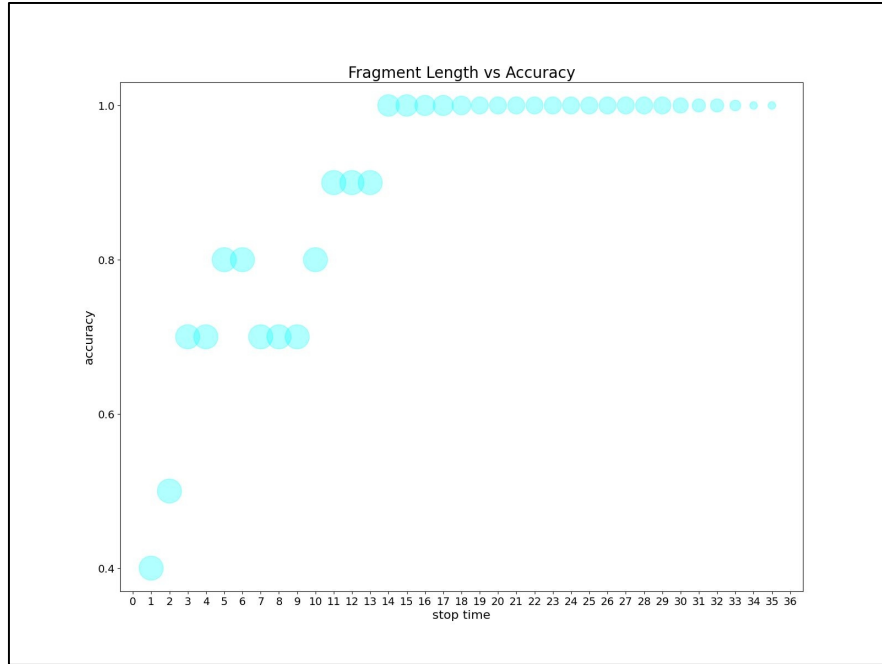
- Resnet18 (Same as used in experiment 1)

Accuracy and Runtime Results (Experiment 2)

	precision	recall	f1-score	support
up_down	0.98	0.84	0.90	50
up_down_back_forth	0.93	0.84	0.88	49
other	0.80	1.00	0.89	57
mod_spiral	1.00	0.98	0.99	61
sim_spiral	0.95	0.99	0.97	79
back_forth	0.96	0.84	0.90	32
accuracy			0.93	328
macro avg	0.94	0.92	0.92	328
weighted avg	0.94	0.93	0.93	328

Test Run Time = 83.38 s (~0.25 s per instance)

Experiment 2 Results



Smallest circle = 1 instance
Largest circle = 10 instances