`thalescogent+0002`

Thales Group

Slap Fingerprint Segmentation Evaluation III

Last Updated: 04 September 2020

Contents

1 Participation Information

1.1 Names and Dates

- **Organization Name:** Thales Group
- **SlapSeg III Identifier:** thalescogent+0002
- **Provided Marketing Name:** "Thales Cogent SlapSeg Library"
- **Application Date:** 19 June 2020
- **First Submission Date:** 23 June 2020 (as version 0001)
- **Validation Date:** 30 June 2020
- **Completion Date:** 01 July 2020

1.2 Libraries

Filename	MD5 Checksum	Size
libslapsegiii_thalescogent_0002.so	95b497b53fabdb31f753fcfb1d7a142b	269.5 Kb

2 Tenprint Cards ("TwoInch" Data)

2.1 Segmentation Timing

All algorithms are run over a small fixed corpus of TwoInch images to estimate the total runtime of the evaluation. To be evaluated under SlapSeg III, algorithms **must** segment the timing corpus, on average, in under 1 500 milliseconds. This maximum reference time is documented in the SlapSeg III test plan, and is subject to change.

Box plots of segmentation times are separated by slap orientation and capture technology in Figure 1. Tabular representations are enumerated in Table 1. Results are reported in milliseconds.

Elapsed Time
Participant: thalescogent+0002, Image Kind: Two Inch

04 September 2020, 03:45:39 PM EDT
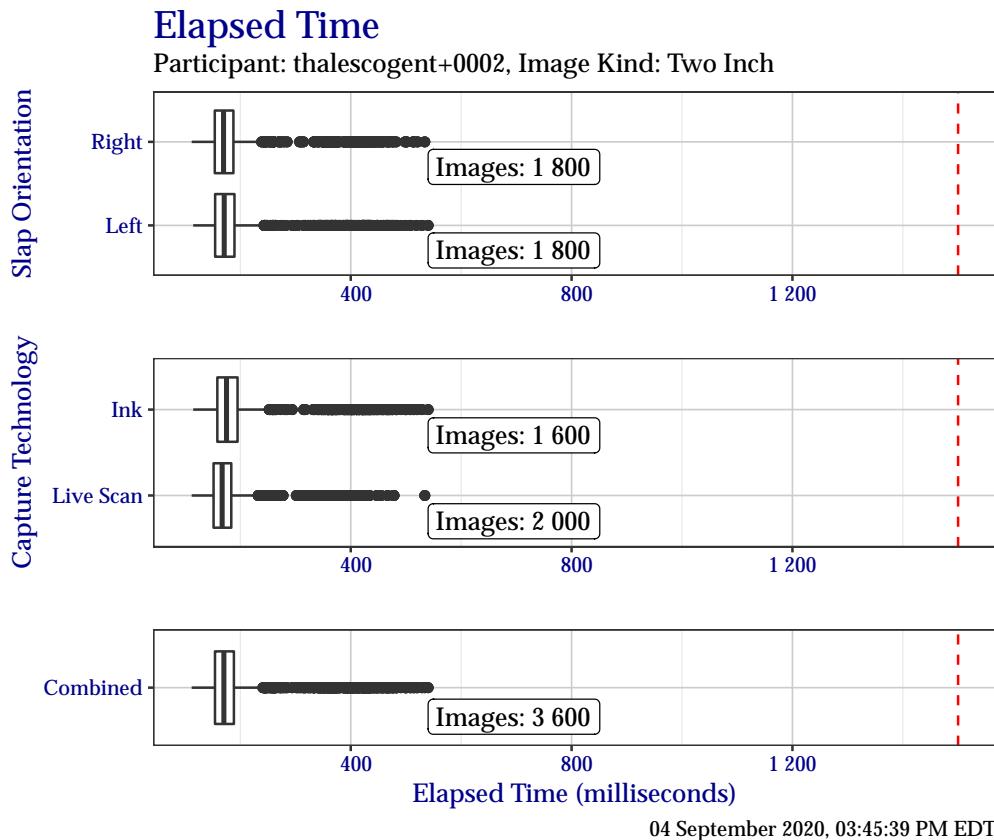
Figure 1: Box plots of elapsed time in milliseconds when segmenting the TwoInch timing test corpus, separated by slap orientation and capture technology.

Table 1: Elapsed time in milliseconds when segmenting the TwoInch timing test corpus, separated by slap orientation and capture technology.

	Right	Left	Live Scan	Ink	Combined
Minimum	112	115	112	115	112
25%	154	154	152	158	154
Median	170	171	167	175	170
75%	188	189	184	195	188
Maximum	534	540	534	540	540

## 2.2   Segmentation Centers and Dimensions

2.2.1   Segmentation Centers
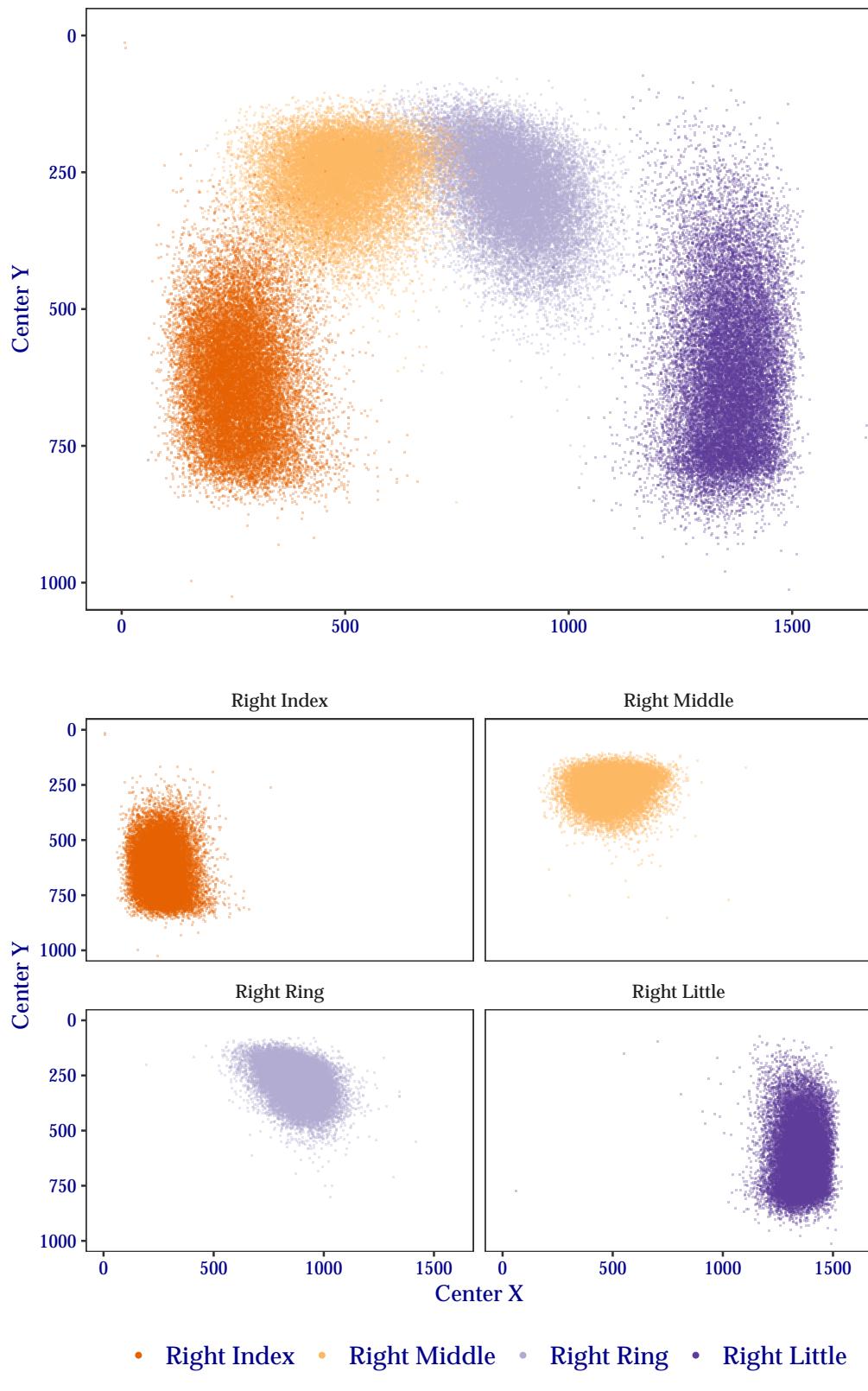
The plots in this section show the distribution of segmentation position centers (x, y) for TwoInch data. At the top of each figure is a combined plot for all finger positions of a given slap orientation. These figures are isolated in plots faceted at the bottom of the figure.

Plots of segmentation centers for the right hand TwoInch data are shown in Figure 2 and plots of segmentation centers for the left hand are shown in Figure 3. Blank lines that may appear in the plots are **not** rendering artifacts. Rather, they are indicative of image downsampling. Centers have been normalized to 500 pixels per inch.

Points in each plot are plotted with a semi-transparent opacity. This results in points of particular color appearing "darker" to indicate a higher frequency of the observed value, while "lighter" points indicate a lower observed frequency.

Segmentation Position Centers

Participant: thalescogent+0002, FRGPs: 2, 3, 4, 5, Image Kind: Two Inch
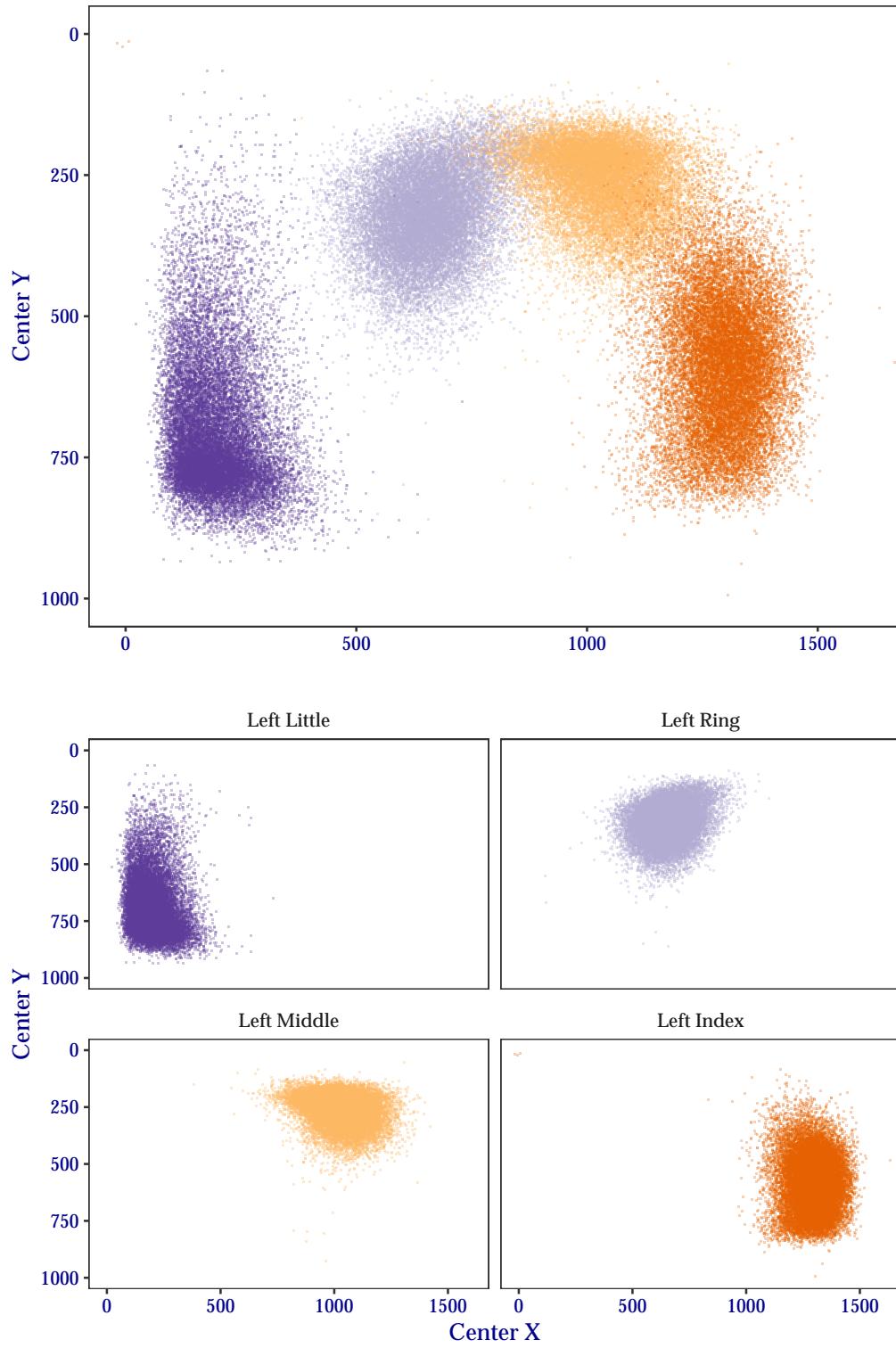
04 September 2020, 04:00:50 PM EDT

Figure 2: Segmentation centers for right hand TwoInch data.

Segmentation Position Centers

Participant: thalescogent+0002, FRGPs: 7, 8, 9, 10, Image Kind: Two Inch

04 September 2020, 04:00:44 PM EDT

Figure 3: Segmentation centers for left hand TwoInch data.
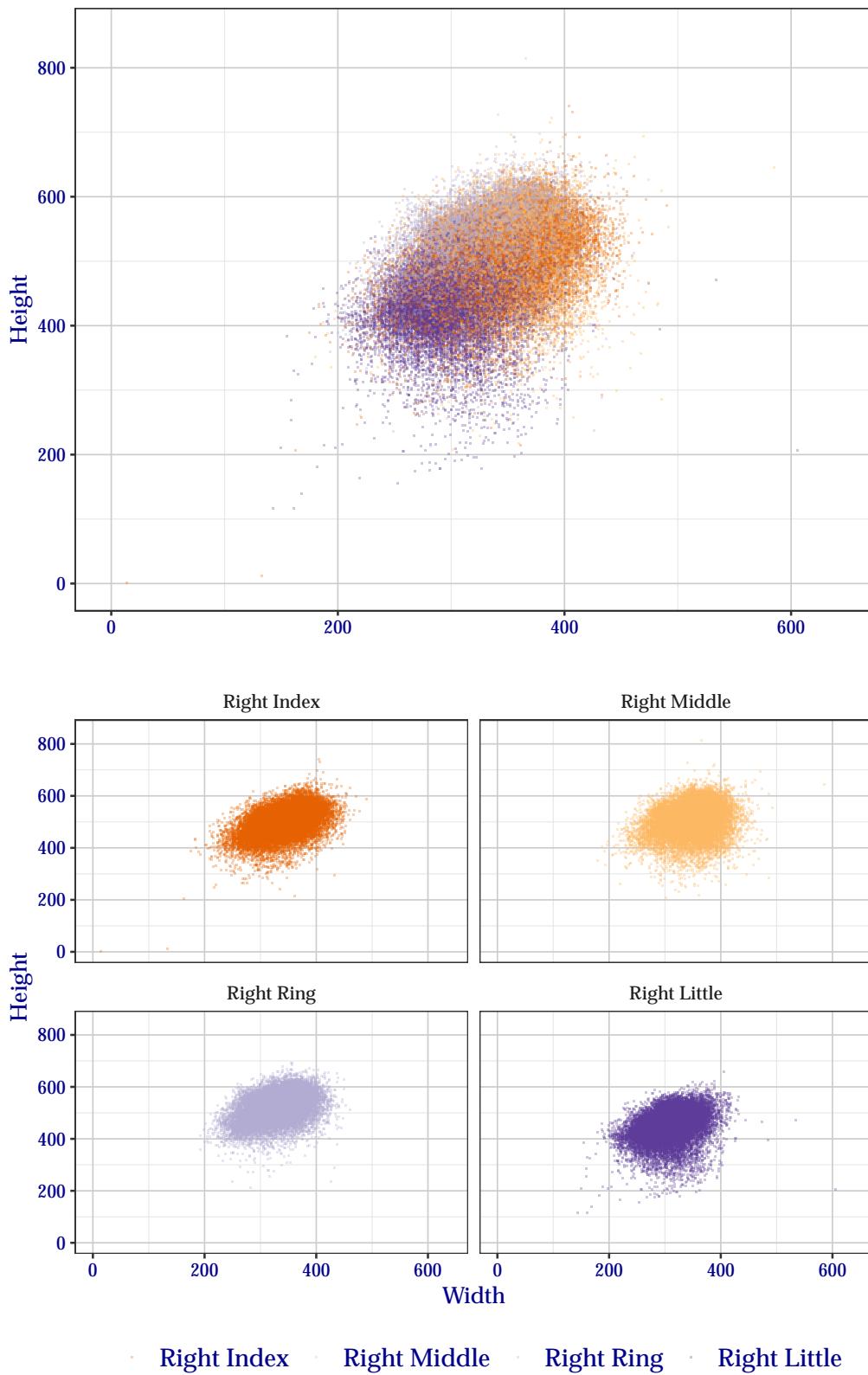
2.2.2   Segmentation Dimensions

The plots in this section show the distribution of segmentation position widths and heights for TwoInch data. At the top of each figure is a combined plot for all finger positions of a given slap orientation. These figures are isolated in plots faceted at the bottom of the figure.

Plots of segmentation position dimensions for the right hand TwoInch data are shown in Figure 4 and the left hand in Figure 5. Blank lines that may appear in the plots are **not** rendering artifacts. Rather, they are indicative of image downsampling. Dimensions have been normalized to 500 pixels per inch.

Segmentation Position Dimensions
Participant: thalescogent+0002, FRGPs: 2, 3, 4, 5, Image Kind: Two Inch
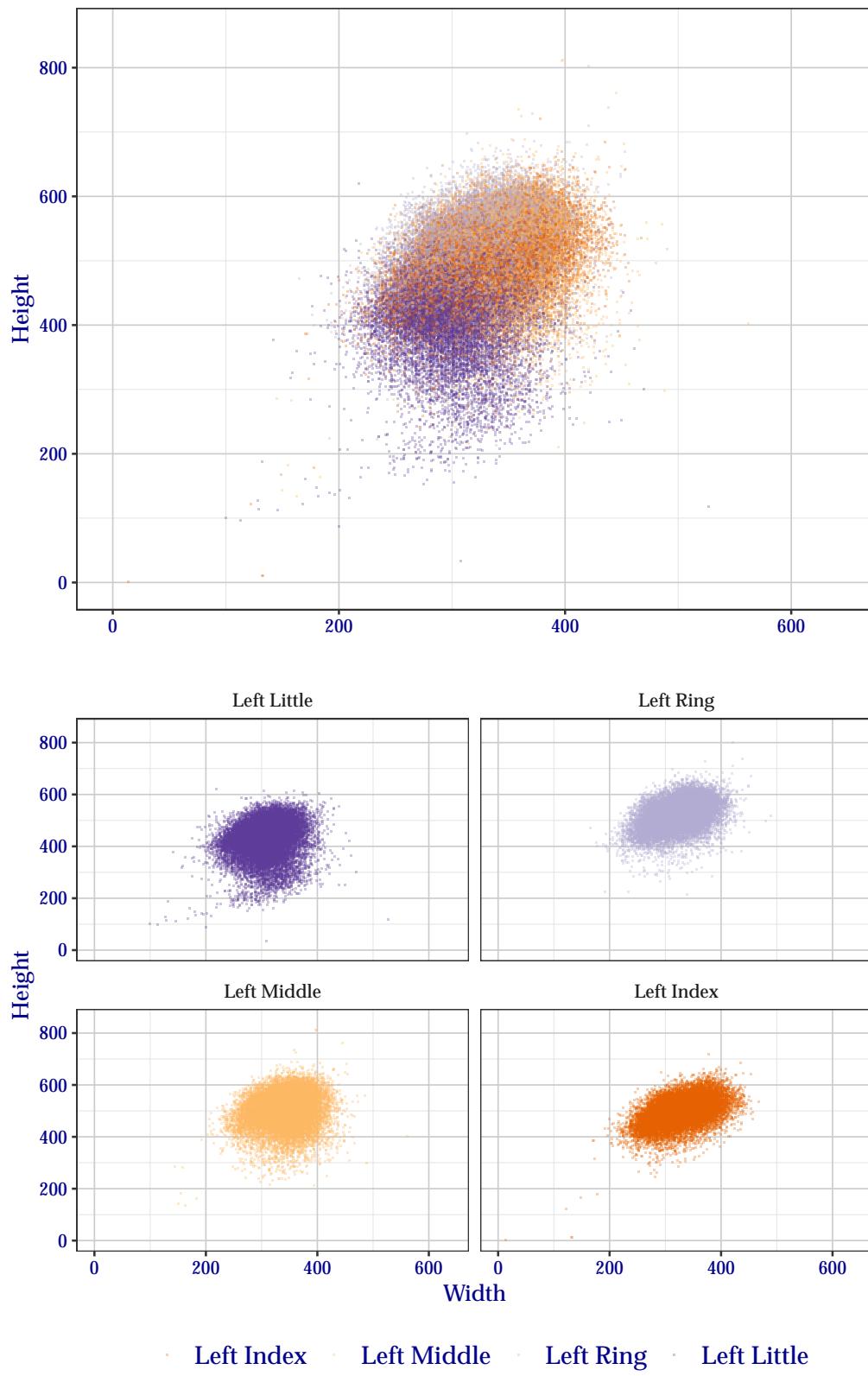
04 September 2020, 04:01:23 PM EDT

Figure 4: Segmentation position dimensions for right hand TwoInch data.

Segmentation Position Dimensions

Participant: thalescogent+0002, FRGPs: 7, 8, 9, 10, Image Kind: Two Inch

04 September 2020, 04:01:17 PM EDT

Figure 5: Segmentation position dimensions for left hand TwoInch data.

2.3   Detailed Segmentation Statistics

This section shows detailed results of segmentation of TwoInch data. Values in each table are the percentage that the variable in the left-most column was correctly segmented.

Each table has three columns of percentages. The *Standard Scoring* column shows the percentage of correctly-segmented positions based on the scoring metrics defined in the SlapSeg III scoring document. The *Ignoring Bottom Y* column shows how the percentage would change if the threshold for the *bottom Y* coordinate of the segmentation position was ignored. Similarly, the *Ignoring Bottom X and Y* columns shows how the percentage would change if only the top, left, and right sides of the segmentation position were considered. These two supplemental columns are included because it has traditionally been difficult to determine the exact location of the distal interphalangeal joint.

Table 2 shows how successful `thalescogent+0002` segmented fingers for each subject in the test corpus. Table 3 shows success for specific finger positions over the entire test corpus. Similarly, Table 4 shows success for segmenting the same finger position from both hands.

The remainder of the tables show success per subject when considering combinations of subsets of the fingers on each slap image. Table 5 shows success for combinations of all fingers, Table 6 for just the index and middle fingers, and Table 7 for all except the little finger.

Table 2: For each subject, the percentage that at least *Number of Fingers* fingers were correctly segmented, regardless of hand, for a maximum of eight correctly-segmented fingers. In *Standard Scoring*, scoring rules are followed exactly. In *Ignoring Bottom Y*, the bottom left and bottom right Y coordinates are ignored. *Ignoring Bottom X and Y* only checks the locations of the top left and top right coordinates.

Number of Fingers	Standard Scoring	Ignoring Bottom Y	Ignoring Bottom X and Y
1	99.9	99.9	99.9
2	99.8	99.8	99.8
3	99.5	99.6	99.7
4	98.7	99.1	99.2
5	94.9	95.0	95.4
6	94.2	94.4	95.0
7	92.2	92.8	93.7
8	83.2	87.0	88.3

Table 3: For all subjects, percentage that a particular friction ridge generalized position was correctly segmented. In *Ignoring Bottom Y*, the bottom left and bottom right Y coordinates are ignored. *Ignoring Bottom X and Y* only checks the locations of the top left and top right coordinates.

Finger	Standard Scoring	Ignoring Bottom Y	Ignoring Bottom X and Y
Right			
Index	96.9	97.5	97.8
Middle	97.4	98.0	98.2
Ring	97.5	98.2	98.5
Little	98.2	98.6	98.9
Left			
Index	96.9	97.4	98.1
Middle	96.6	97.5	98.5
Ring	96.9	98.0	98.6
Little	98.0	98.3	98.6

Table 4: Percentage that a particular type of fingerprint was correctly segmented on *Either* or *Both* hands. In *Ignoring Bottom Y*, the bottom left and bottom right Y coordinates are ignored. *Ignoring Bottom X and Y* only checks the locations of the top left and top right coordinates.

Fingers	Standard Scoring	Ignoring Bottom Y	Ignoring Bottom X and Y
Index			
Either	99.3	99.5	99.6
Both	90.6	91.6	92.3
Middle			
Either	99.3	99.5	99.7
Both	90.7	92.0	93.0
Ring			
Either	99.2	99.5	99.6
Both	91.3	92.7	93.6
Little			
Either	99.5	99.6	99.6
Both	92.4	93.1	93.7

Table 5: Percentage of segmentation success by hand for combinations of all eight fingers of a TwoInch slap. In *Ignoring Bottom Y*, the bottom left and bottom right Y coordinates are ignored. *Ignoring Bottom X and Y* only checks the locations of the top left and top right coordinates.

Fingers	Standard Scoring	Ignoring Bottom Y	Ignoring Bottom X and Y
Right			
Any	99.6	99.6	99.7
At Least Two	99.2	99.3	99.6
At Least Three	98.4	98.6	98.9
All Four	92.8	94.8	95.2
Left			
Any	99.5	99.6	99.8
At Least Two	99.1	99.1	99.6
At Least Three	97.8	98.2	99.0
All Four	91.9	94.4	95.5

Table 6: Percentage of segmentation success by hand when only considering combinations of index and middle fingers. In *Ignoring Bottom Y*, the bottom left and bottom right Y coordinates are ignored. *Ignoring Bottom X and Y* only checks the locations of the top left and top right coordinates.

Fingers	Standard Scoring	Ignoring Bottom Y	Ignoring Bottom X and Y
Right			
Either Index or Middle	99.2	99.2	99.4
Both Index and Middle	95.1	96.3	96.6
Left			
Either Index or Middle	98.8	98.9	99.5
Both Index and Middle	94.7	96.0	97.1

Table 7: Percentage of segmentation success by hand when only considering combinations of index, middle, and ring fingers. In *Ignoring Bottom Y*, the bottom left and bottom right Y coordinates are ignored. *Ignoring Bottom X and Y* only checks the locations of the top left and top right coordinates.

Fingers	Standard Scoring	Ignoring Bottom Y	Ignoring Bottom X and Y
Right			
Any	99.4	99.4	99.7
At Least Two	98.6	98.8	99.1
All Three	93.7	95.5	95.8
Left			
Any	99.3	99.3	99.7
At Least Two	98.2	98.5	99.2
All Three	92.9	95.1	96.2

2.4 Handling Troublesome Images

2.4.1 Capture Failures

Segmentation algorithms may refuse to process an image. This may happen for a technical reason (e.g., the algorithm cannot parse the image data), or for a practical reason (e.g., the hand in the image is placed incorrectly). These failure scenarios are the result of capturing improper image data. In these types of scenarios, it is important to examine the cause of the failure. With many live scan capture setups, segmentation is performed immediately after capture. If an algorithm can detect that it won't be able to segment an image due to a technical or practical issue, it can alert the operator to perform a recapture before the subject leaves.

The SlapSeg III API encourages algorithms to identify these failure reasons by specifying pre-defined *deficiencies* in the image. Algorithms should attempt segmentation even if an image deficiency is encountered if at all possible. Note that SlapSeg III *guarantees* well-formed image data, so failures to parse are **not** an indicator of the data provided.

`thalescogent+0002` did **not** report any capture failures.

2.4.1.1 Recovery

When encountering a segmentation failure, SlapSeg III algorithms are encouraged to provide a *best-effort* segmentation when possible. In some cases, that best-effort may be correct, which reduces the amount of images that need to be manually adjudicated by an operator.

`thalescogent+0002` did not attempt any recovery segmentations.

2.4.2 Segmentation Failures

Even if an algorithm accepts an image for processing, it can still fail to process one or more fingers from the image, regardless of if the algorithm requested a recapture and provided best-effort segmentation.

The SlapSeg III API allows algorithms to communicate reasons for failure to process these fingers. In some cases, the distal phalanx in question might not be present in the image due to amputation or being placed outside the platen's capture area. It is imperative that the segmentation algorithm correctly report this as failing to segment the correct friction ridge generalized position without disrupting the sequence of valid positions present in the image. This can help prompt an operator to recapture or record additional information about the subject.

In SlapSeg III, a number of images are missing fingers or otherwise have fingers that will not be able to be segmented. Reasons for segmentation failures reported by `thalescogent+0002` are enumerated in Table 8.

Table 8: Count of self-reported segmentation failure reasoning.

Failure Reason	Fingers
Finger Not Found	93
Finger Found, but Can't Segment	0
Vendor Defined	0

2.4.3 Identifying Missing Fingers

A small portion of the test corpus in SlapSeg III are missing fingers. Table 9 shows how successful `thalescogent+0002` was in correctly determining if a finger was missing. The *Missed* row shows when a segmentation position was returned for a missing finger. All possible failure reasons are enumerated, but are

not considered *Correctly Identified* because the algorithm specified failure for a reason other than the finger not being found.

Table 9: Performance of `thalescogent+0002` at detecting fingers missing from an image.

Result	Percentage
Missed	46.9
Correctly Identified	53.1
Other Failure: Finger Found, but Can't Segment	0.0
Other Failure: Vendor Defined	0.0
Other Failure: Segmentation Not Attempted	0.0

2.4.4   Sequence Error

Sequence error occurs when a fingerprint is segmented from an image but assigned an incorrect finger position (e.g., segmenting a right middle finger but labeling it a right index finger). Table 10 shows cases in which a segmentation position was returned that matched a ground truth segmentation position for a different finger in the same image.

Table 10: Percentage of images in the dataset where one or more segmentation positions correctly matched an incorrect finger position within the same image, indicating sequence error.

Hand	Standard Scoring	Ignoring Bottom Y	Ignoring Bottom X and Y
Left	0.02	0.02	0.04
Right	0.05	0.05	0.07
Combined	0.04	0.04	0.06

2.5   Determining Orientation

An *optional* portion of the SlapSeg III API asked participants to determine the hand orientation of an image. Participants were provided the kind (e.g., Tenprint card) and capture technology (e.g., ink), and needed to determine whether the image was of the left or right hand.

Overall Two Inch accuracy: 99.7%

Table 11: Percentage of accuracy when determining hand orientation of a two inch image. The first column indicates the true hand orientation. Subsequent columns indicate the percentage of the time in which the indicated hand orientation was hypothesized.

	Left	Right
Left	**99.7**	0.3
Right	0.2	**99.8**

3   Identification Flats ("ThreeInch" Data)

3.1   Segmentation Timing

All algorithms are run over a small fixed corpus of ThreeInch images to estimate the total runtime of the evaluation. To be evaluated under SlapSeg III, algorithms **must** segment the timing corpus, on average, in under 1 500 milliseconds. This maximum reference time is documented in the SlapSeg III test plan, and is subject to change.

Box plots of segmentation times are separated by hand in Figure 6, with tabular representations are enumerated in Table 12. Results are reported in milliseconds
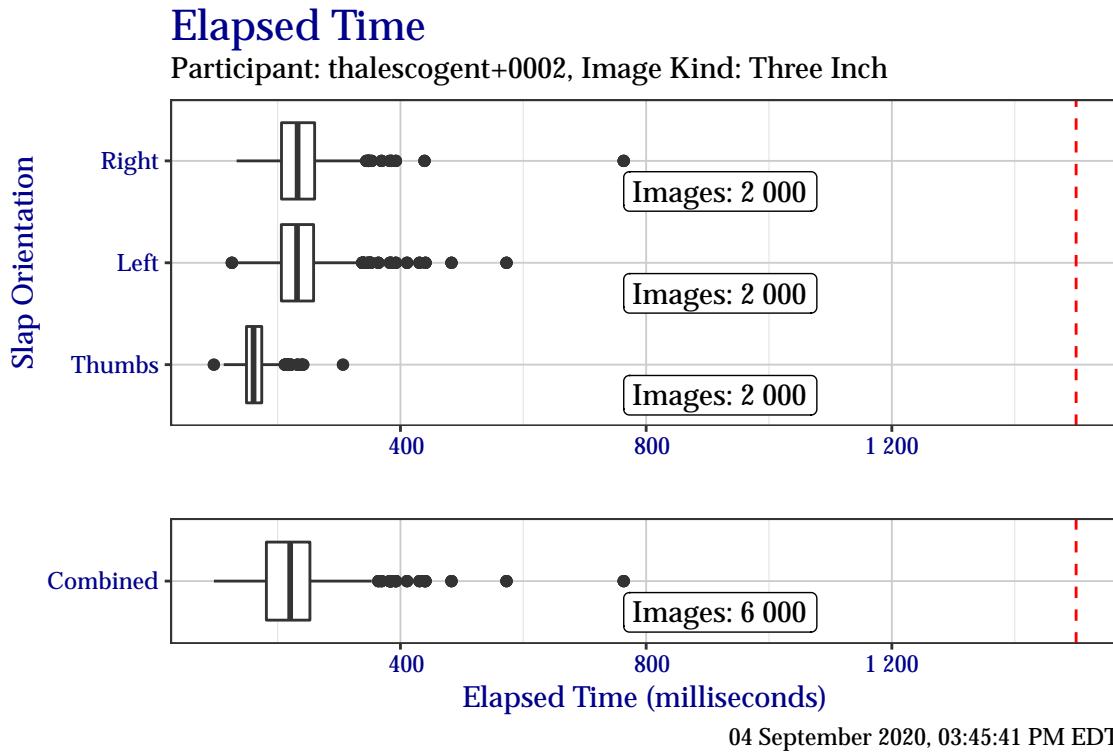
Figure 6: Box plots of elapsed time in milliseconds when segmenting the ThreeInch timing test corpus, separated by slap orientation.

Table 12: Elapsed time in milliseconds when segmenting the ThreeInch timing test corpus, separated by slap orientation.

	Right	Left	Thumbs	Combined
Minimum	133	126	96	96
25%	206	206	149	182
Median	233	232	161	220
75%	260	259	174	253
Maximum	763	573	306	763

3.2   Segmentation Centers and Dimensions

3.2.1   Segmentation Centers
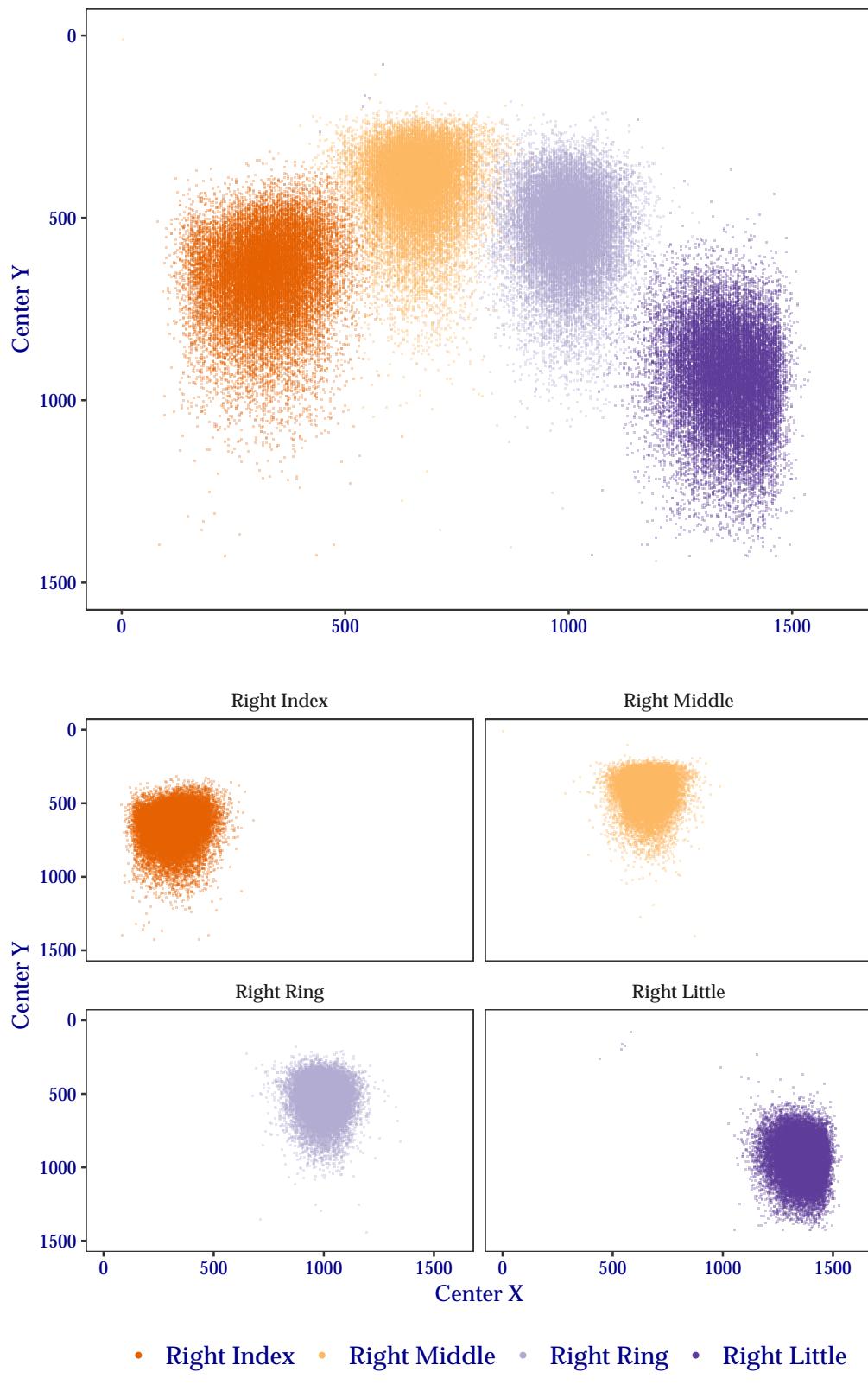
The plots in this section show the distribution of segmentation position centers (x, y) for ThreeInch data. At the top of each figure is a combined plot for all finger positions of a given hand orientation. These figures are isolated in plots faceted at the bottom of the figure.

Plots of segmentation centers for the right hand ThreeInch data are shown in Figure 7, for the left hand in Figure 8, and for thumbs in Figure 9. Blank lines that may appear in the plots are **not** rendering artifacts. Rather, they are indicative of image downsampling. Centers have been normalized to 500 pixels per inch.

Points in each plot are plotted with a semi-transparent opacity. This results in points of particular color appearing "darker" to indicate a higher frequency of the observed value, while "lighter" points indicate a lower observed frequency.

Segmentation Position Centers

Participant: thalescogent+0002, FRGPs: 2, 3, 4, 5, Image Kind: Three Inch

04 September 2020, 04:01:05 PM EDT

Figure 7: Segmentation centers for right hand ThreeInch data.

Segmentation Position Centers

Participant: thalescogent+0002, FRGPs: 7, 8, 9, 10, Image Kind: Three Inch

04 September 2020, 04:00:57 PM EDT
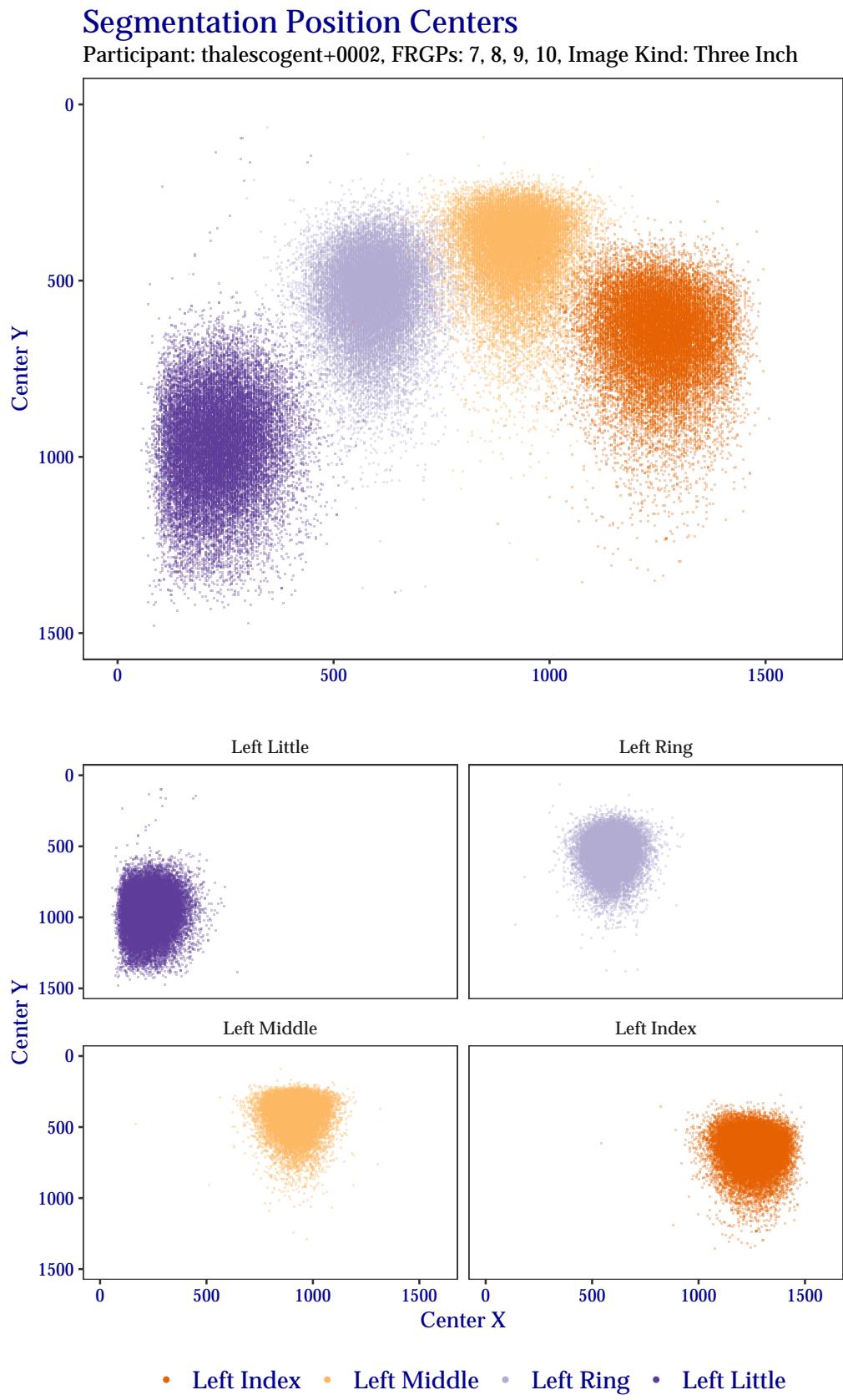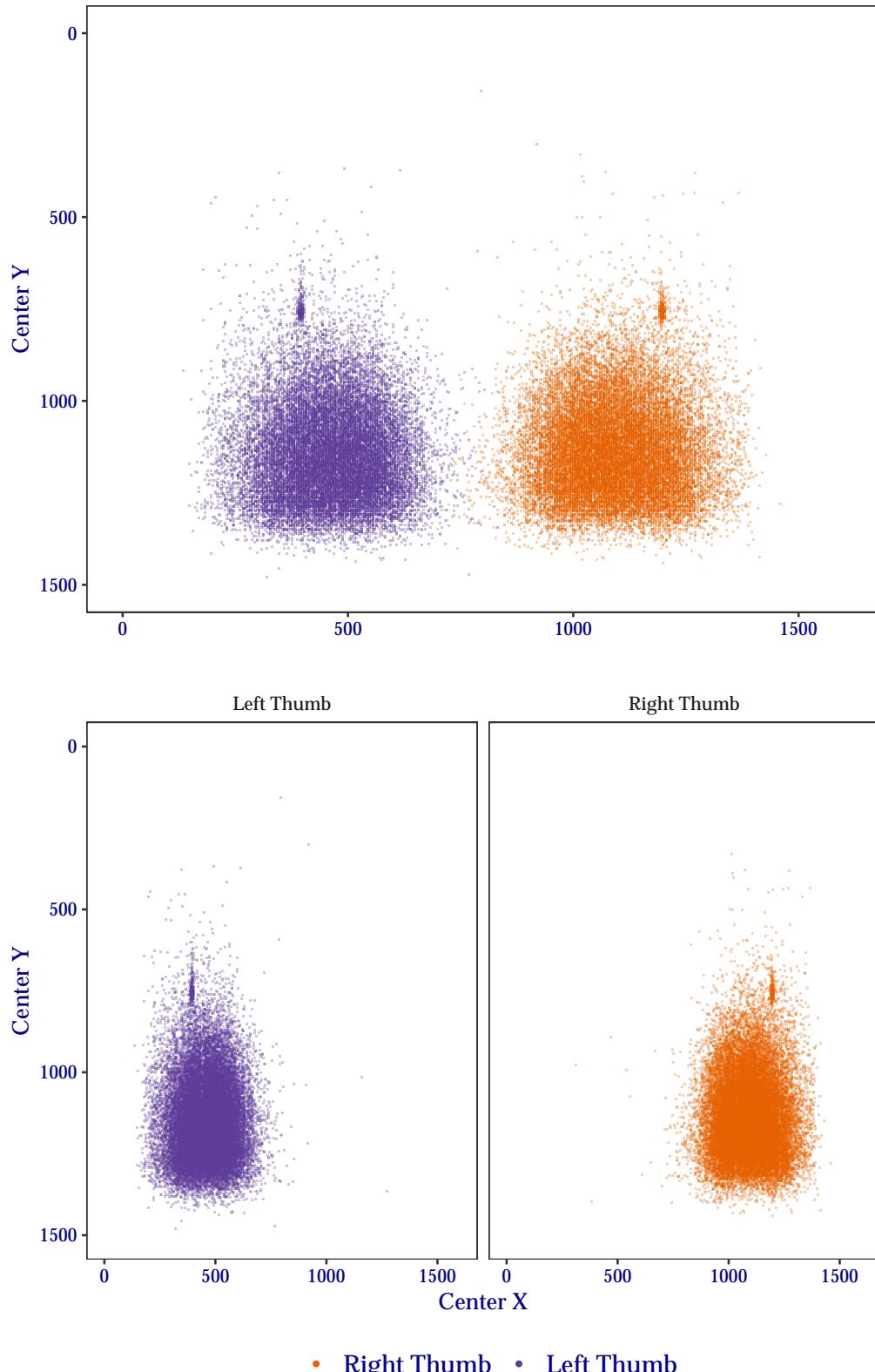
Figure 8: Segmentation centers for left hand ThreeInch data.

Segmentation Position Centers

Participant: thalescogent+0002, FRGPs: 1, 6, Image Kind: Three Inch

Left Thumb   Right Thumb

• Right Thumb • Left Thumb

04 September 2020, 04:01:12 PM EDT

Figure 9: Segmentation centers for thumb ThreeInch data.
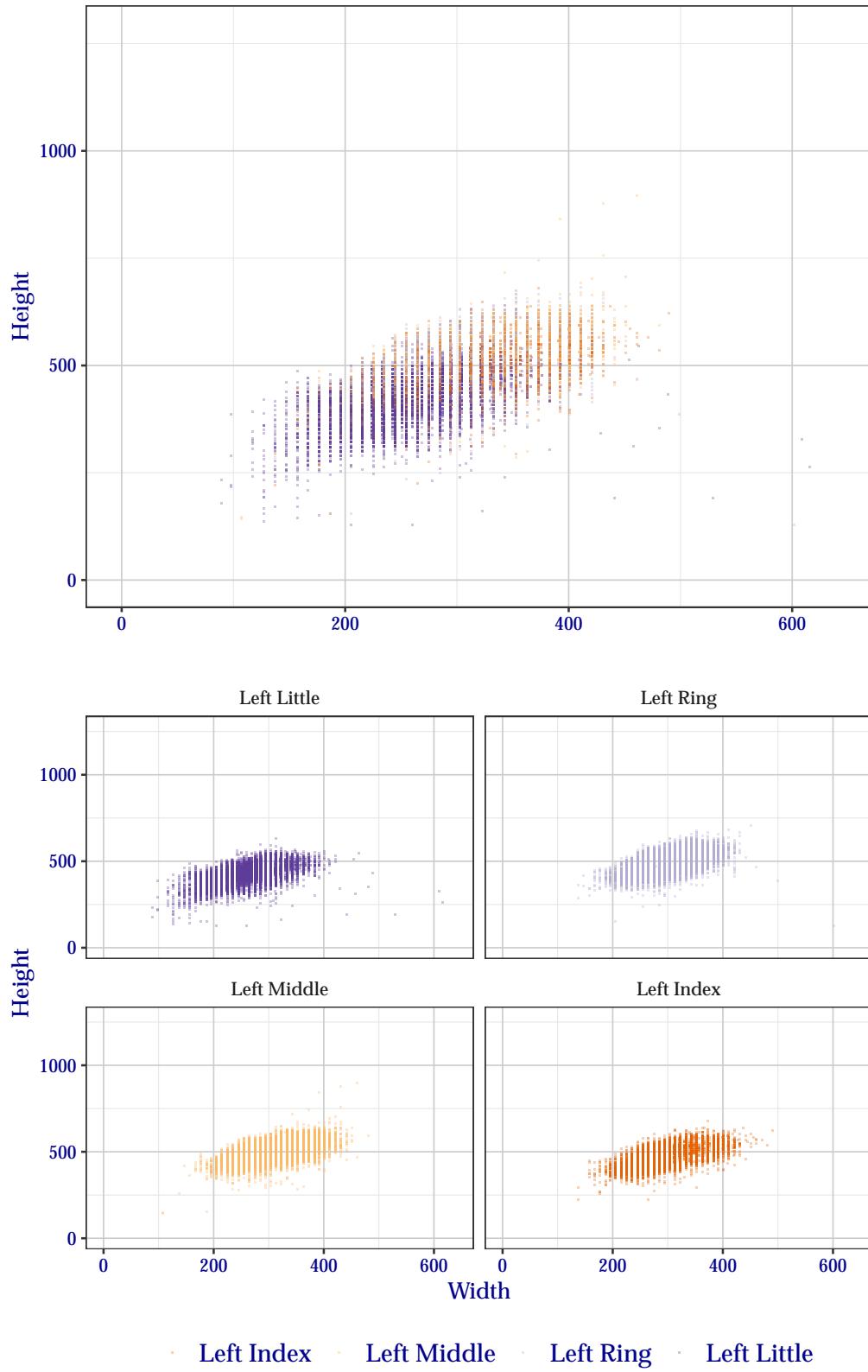
3.2.2 Segmentation Dimensions

The plots in this section show the distribution of segmentation position widths and heights for ThreeInch data. At the top of each figure is a combined plot for all finger positions of a given hand orientation. These figures are isolated in plots faceted at the bottom of the figure.

Plots of segmentation position dimensions for the right hand ThreeInch data are shown in Figure 11, for the left hand in Figure 10, and for thumbs in Figure 12. Blank lines that may appear in the plots are **not** rendering artifacts. Rather, they are indicative of image downsampling. Dimensions have been normalized to 500 pixels per inch.

Segmentation Position Dimensions

Participant: thalescogent+0002, FRGPs: 7, 8, 9, 10, Image Kind: Three Inch

04 September 2020, 04:01:30 PM EDT

Figure 10: Segmentation position dimensions for left hand ThreeInch data.

Segmentation Position Dimensions

Participant: thalescogent+0002, FRGPs: 2, 3, 4, 5, Image Kind: Three Inch

04 September 2020, 04:01:36 PM EDT
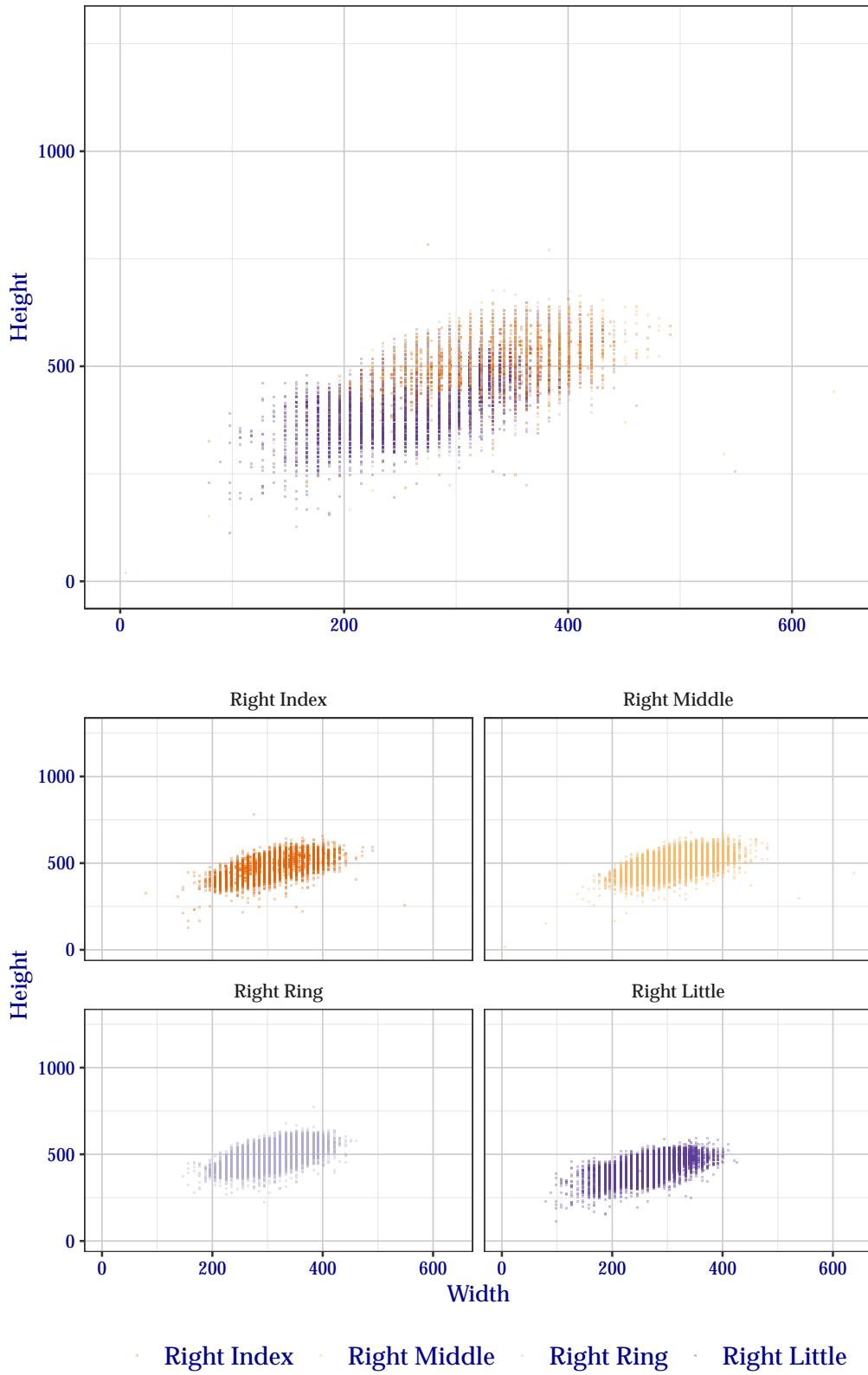
Figure 11: Segmentation position dimensions for right hand ThreeInch data.

Segmentation Position Dimensions

Participant: thalescogent+0002, FRGPs: 1, 6, Image Kind: Three Inch

Right Thumb   ·   Left Thumb

04 September 2020, 04:01:44 PM EDT
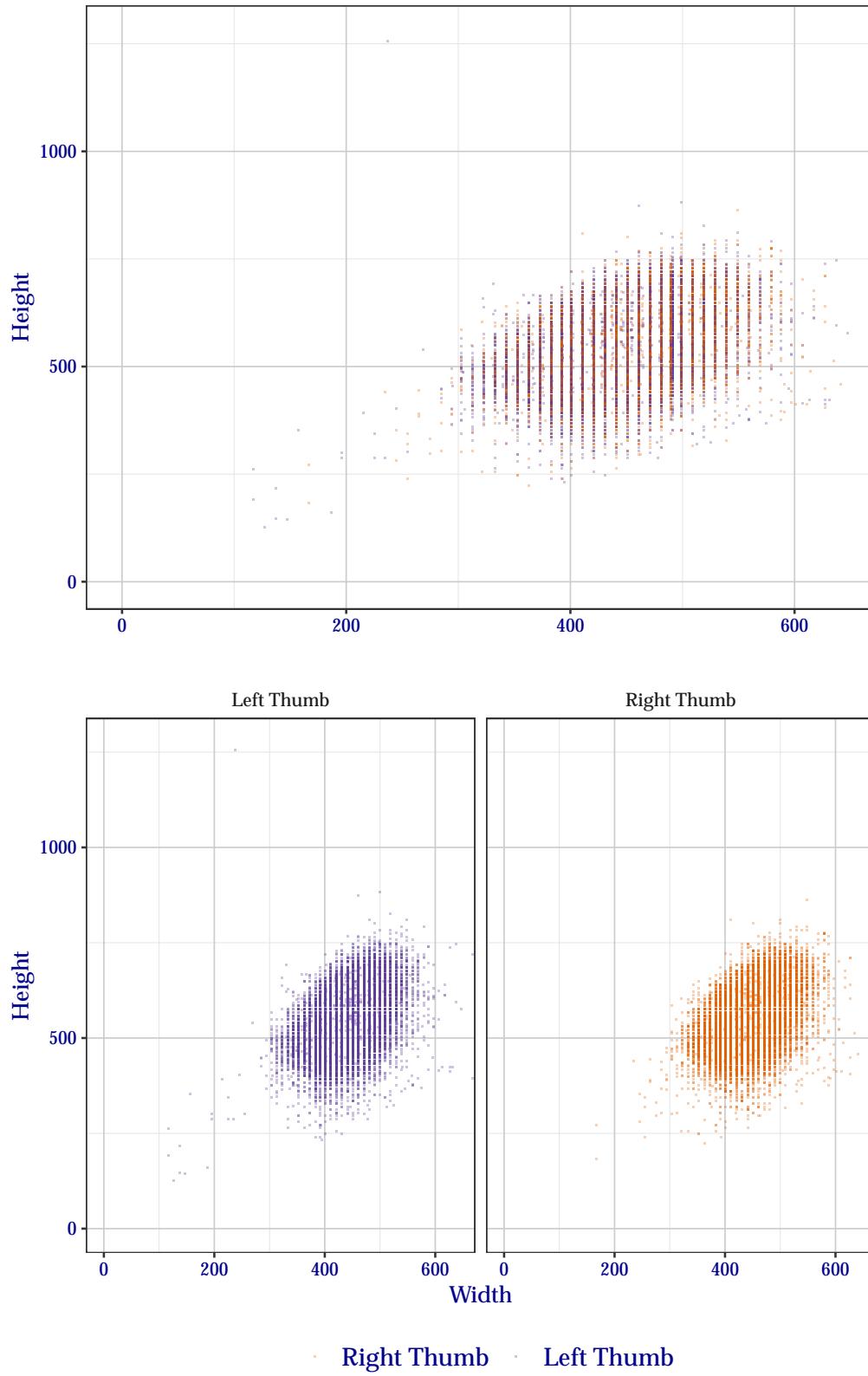
Figure 12: Segmentation position dimensions for thumb ThreeInch data.

3.3 Detailed Segmentation Statistics

This section shows detailed results of segmentation of ThreeInch data. Values in each table are the percentage that the variable in the left-most column was correctly segmented.

Each table has three columns of percentages. The *Standard Scoring* column shows the percentage of correctly-segmented positions based on the scoring metrics defined in the SlapSeg III scoring document. The *Ignoring Bottom Y* column shows how the percentage would change if the threshold for the *bottom Y* coordinate of the segmentation position was ignored. Similarly, the *Ignoring Bottom X and Y* columns shows how the percentage would change if only the top, left, and right sides of the segmentation position were considered. These two supplemental columns are included because it has traditionally been difficult to determine the exact location of the distal interphalangeal joint.

Table 13 shows how successful `thalescogent+0002` segmented fingers for each subject in the test corpus. Table 14 shows success for specific finger positions over the entire test corpus. Similarly, Table 15 shows success for segmenting the same finger position from both hands.

The remainder of the tables show success per subject when considering combinations of subsets of the fingers on each slap image. Table 16 shows success for combinations of all fingers, Table 17 for just the index and middle fingers, and Table 18 for all except the little finger.

Table 13: For each subject, the percentage that at least *Number of Fingers* fingers were correctly segmented, regardless of hand, for a maximum of eight correctly-segmented fingers. In *Standard Scoring*, scoring rules are followed exactly. In *Ignoring Bottom Y*, the bottom left and bottom right Y coordinates are ignored. *Ignoring Bottom X and Y* only checks the locations of the top left and top right coordinates.

Number of Fingers	Standard Scoring	Ignoring Bottom Y	Ignoring Bottom X and Y
1	100.0	100.0	100.0
2	99.8	99.8	99.9
3	98.5	98.5	98.6
4	98.2	98.3	98.3
5	95.9	95.9	95.9
6	95.9	95.9	95.9
7	95.8	95.9	95.9
8	95.6	95.7	95.8
9	94.3	94.8	95.5
10	86.2	88.7	92.2

Table 14: For all subjects, percentage that a particular friction ridge generalized position was correctly segmented. In *Ignoring Bottom Y*, the bottom left and bottom right Y coordinates are ignored. *Ignoring Bottom X and Y* only checks the locations of the top left and top right coordinates.

Finger	Standard Scoring	Ignoring Bottom Y	Ignoring Bottom X and Y
Right			
Thumb	98.1	98.5	99.3
Index	99.2	99.5	99.6
Middle	98.8	99.3	99.7
Ring	98.4	98.9	99.6
Little	98.7	98.9	99.2
Left			
Thumb	98.2	98.6	99.3
Index	99.1	99.2	99.4
Middle	98.8	99.2	99.6
Ring	98.7	98.9	99.7
Little	98.9	99.1	99.3

Table 15: Percentage that a particular type of fingerprint was correctly segmented on *Either* or *Both* hands. In *Ignoring Bottom Y*, the bottom left and bottom right Y coordinates are ignored. *Ignoring Bottom X and Y* only checks the locations of the top left and top right coordinates.

Fingers	Standard Scoring	Ignoring Bottom Y	Ignoring Bottom X and Y
Thumb			
Either	99.6	99.7	99.9
Both	96.8	97.5	98.8
Index			
Either	99.9	99.9	99.9
Both	95.7	96.1	96.4
Middle			
Either	99.7	99.8	99.9
Both	95.3	96.0	96.7
Ring			
Either	99.8	99.8	99.9
Both	94.6	95.3	96.7
Little			
Either	99.7	99.7	99.8
Both	95.2	95.5	96.1

Table 16: Percentage of segmentation success by hand for combinations of all ten fingers of a ThreeInch slap. In *Ignoring Bottom Y*, the bottom left and bottom right Y coordinates are ignored. *Ignoring Bottom X and Y* only checks the locations of the top left and top right coordinates.

Fingers	Standard Scoring	Ignoring Bottom Y	Ignoring Bottom X and Y
Right			
Any	99.9	99.9	99.9
At Least Two	98.5	98.5	98.5
At Least Three	98.4	98.5	98.5
At Least Four	97.8	98.1	98.3
All Five	89.4	90.9	93.0
Left			
Any	99.9	99.9	99.9
At Least Two	98.5	98.5	98.5
At Least Three	98.4	98.4	98.5
At Least Four	97.7	97.9	98.2
All Five	89.9	91.1	93.0

Table 17: Percentage of segmentation success by hand when only considering combinations of index and middle fingers. In *Ignoring Bottom Y*, the bottom left and bottom right Y coordinates are gnored. *Ignoring Bottom X and Y* only checks the locations of the top left and top right coordinates.

Fingers	Standard Scoring	Ignoring Bottom Y	Ignoring Bottom X and Y
Right			
Either	99.9	99.9	100.0
Both	98.1	98.9	99.3
Left			
Either	99.9	99.9	99.9
Both	98.0	98.5	99.1

Table 18: Percentage of segmentation success by hand when only considering combinations of index, middle, and ring fingers. In *Ignoring Bottom Y*, the bottom left and right Y coordinates are ignored. *Ignoring Bottom X and Y* only checks the locations of the top left and right coordinates.

Fingers	Standard Scoring	Ignoring Bottom Y	Ignoring Bottom X and Y
Right			
Any	99.9	100.0	100.0
At Least Two	99.7	99.8	99.9
All Three	96.7	97.9	99.0
Left			
Any	100.0	100.0	100.0
At Least Two	99.8	99.8	99.9
All Three	96.8	97.6	98.9

3.4 Handling Troublesome Images

3.4.1 Capture Failures

Segmentation algorithms may refuse to process an image. This may happen for a technical reason (e.g., the algorithm cannot parse the image data), or for a practical reason (e.g., the hand in the image is placed incorrectly). These failure scenarios are the result of capturing improper image data. In these types of scenarios, it is important to examine the cause of the failure. With many live scan capture setups, segmentation is performed immediately after capture. If an algorithm can detect that it won't be able to segment an image due to a technical or practical issue, it can alert the operator to perform a recapture before the subject leaves.

The SlapSeg III API encourages algorithms to identify these failure reasons by specifying pre-defined *deficiencies* in the image. Algorithms should attempt segmentation even if an image deficiency is encountered if at all possible. Note that SlapSeg III *guarantees* well-formed image data, so failures to parse are **not** an indicator of the data provided.

`thalescogent+0002` did **not** report any capture failures.

3.4.1.1 Recovery

When encountering a segmentation failure, SlapSeg III algorithms are encouraged to provide a *best-effort* segmentation when possible. In some cases, that best-effort may be correct, which reduces the amount of images that need to be manually adjudicated by an operator.

`thalescogent+0002` did not attempt any recovery segmentations.

3.4.2 Segmentation Failures

Even if an algorithm accepts an image for processing, it can still fail to process one or more fingers from the image, regardless of if the algorithm requested a recapture and provided best-effort segmentation.

The SlapSeg III API allows algorithms to communicate reasons for failure to process these fingers. In some cases, the distal phalanx in question might not be present in the image due to amputation or being placed outside the platen's capture area. It is imperative that the segmentation algorithm correctly report this as failing to segment the correct friction ridge generalized position without disrupting the sequence of valid positions present in the image. This can help prompt an operator to recapture or record additional information about the subject.

In SlapSeg III, a number of images are missing fingers or otherwise have fingers that will not be able to be segmented. Reasons for segmentation failures reported by `thalescogent+0002` are enumerated in Table 19.

Table 19: Count of self-reported segmentation failure reasoning.

Failure Reason	Fingers
Finger Not Found	105
Finger Found, but Can't Segment	0
Vendor Defined	0

3.4.3 Identifying Missing Fingers

A small portion of the test corpus in SlapSeg III are missing fingers. Table 20 shows how successful `thalescogent+0002` was in correctly determining if a finger was missing. The *Missed* row shows when a segmentation position was returned for a missing finger. All possible failure reasons are enumerated, but are

not considered *Correctly Identified* because the algorithm specified failure for a reason other than the finger not being found.

Table 20: Performance of `thalescogent+0002` at detecting fingers missing from an image.

Result	Percentage
Missed	50.4
Correctly Identified	49.6
Other Failure: Finger Found, but Can't Segment	0.0
Other Failure: Vendor Defined	0.0
Other Failure: Segmentation Not Attempted	0.0

3.4.4   Sequence Error

Sequence error occurs when a fingerprint is segmented from an image but assigned an incorrect finger position (e.g., segmenting a right middle finger but labeling it a right index finger). Table 21 shows cases in which a segmentation position was returned that matched a ground truth segmentation position for a different finger in the same image.

Table 21: Percentage of images in the dataset where one or more segmentation positions correctly matched an incorrect finger position within the same image, indicating sequence error.

Hand	Standard Scoring	Ignoring Bottom Y	Ignoring Bottom X and Y
Left	0.04	0.04	0.04
Right	0.04	0.04	0.04
Thumbs	0.08	0.08	0.08
Combined	0.06	0.06	0.06

3.5 Determining Orientation

An *optional* portion of the SlapSeg III API asked participants to determine the hand orientation of an image. Participants were provided the kind (e.g., Identification Flat) and needed to determine whether the image was of the left hand, right hand, or thumbs.

Overall Three Inch accuracy: 99.5%

Table 22: Percentage of accuracy when determining hand orientation of a three inch image. The first column indicates the true hand orientation. Subsequent columns indicate the percentage of the time in which the indicated hand orientation was hypothesized.

	Left	Right	Thumbs
Left	**99.8**	0.2	0
Right	0.6	**99.4**	0
Thumbs	0.3	0.3	**99.4**

A Tenprint Cards ("TwoInch" Data)

A.1 Bootstrap Confidence for Segmentation Statistics

This section shows the same detailed results of segmentation of TwoInch data from Section 2.3, but with an added bootstrap confidence interval. For each observation, a bootstrap routine with 1 000 replicates was run, and a 95 % confidence interval extracted. The lower and upper confidence from that confidence interval are printed in each column within square brackets.

In Table 23, results are shown of how successful `thalescogent+0002` segmented fingers for each subject in the test corpus. Table 24 shows success for specific finger positions over the entire test corpus. Similarly, Table 25 shows success for segmenting the same finger position from both hands.

The remainder of the tables show success per subject when considering combinations of subsets of the fingers in each slap image. Table 26 shows success for combinations of all fingers, Table 28 for the all except the little finger, and Table 27 for just the index and middle fingers.

Table 23: For each subject, the percentage that at least *Number of Fingers* fingers were correctly segmented, regardless of hand, for a maximum of eight correctly-segmented fingers. In *Standard Scoring*, scoring rules are followed exactly. In *Ignoring Bottom Y*, the bottom left and bottom right Y coordinates are ignored. *Ignoring Bottom X and Y* only checks the locations of the top left and top right coordinates. Values in square brackets represent a 95 % confidence interval after bootstrapping with 1 000 replicates.

Number of Fingers	Standard Scoring	Ignoring Bottom Y	Ignoring Bottom X and Y
1	99.9 [99.8, 99.9]	99.9 [99.8, 99.9]	99.9 [99.9, 100.0]
2	99.8 [99.7, 99.9]	99.8 [99.7, 99.9]	99.8 [99.8, 99.9]
3	99.5 [99.3, 99.6]	99.6 [99.5, 99.7]	99.7 [99.6, 99.8]
4	98.7 [98.5, 98.9]	99.1 [98.9, 99.3]	99.2 [99.0, 99.4]
5	94.9 [94.6, 95.3]	95.0 [94.6, 95.4]	95.4 [95.1, 95.8]
6	94.2 [93.8, 94.6]	94.4 [94.0, 94.8]	95.0 [94.6, 95.4]
7	92.2 [91.7, 92.6]	92.8 [92.3, 93.2]	93.7 [93.3, 94.1]
8	83.2 [82.5, 83.8]	87.0 [86.4, 87.6]	88.3 [87.7, 88.8]

Table 24: For all subjects, Percentage that a particular friction ridge generalized position was correctly segmented. In *Ignoring Bottom Y*, the bottom left and bottom right Y coordinates are ignored. *Ignoring Bottom X and Y* only checks the locations of the top left and top right coordinates. Values in square brackets represent a 95 % confidence interval after bootstrapping with 1 000 replicates.

Finger	Standard Scoring	Ignoring Bottom Y	Ignoring Bottom X and Y
Right			
Index	96.9 [96.6, 97.1]	97.5 [97.3, 97.7]	97.8 [97.6, 97.9]
Middle	97.4 [97.2, 97.7]	98.0 [97.8, 98.2]	98.2 [98.1, 98.4]
Ring	97.5 [97.2, 97.6]	98.2 [98.0, 98.3]	98.5 [98.4, 98.7]
Little	98.2 [98.0, 98.4]	98.6 [98.5, 98.8]	98.9 [98.8, 99.1]
Left			
Index	96.9 [96.7, 97.1]	97.4 [97.2, 97.7]	98.1 [97.9, 98.3]
Middle	96.6 [96.3, 96.9]	97.5 [97.3, 97.7]	98.5 [98.4, 98.7]
Ring	96.9 [96.6, 97.1]	98.0 [97.8, 98.2]	98.6 [98.4, 98.7]
Little	98.0 [97.8, 98.2]	98.3 [98.1, 98.5]	98.6 [98.5, 98.8]

Table 25: Percentage that a particular type of fingerprint was correctly segmented on *Either* or *Both* hands. In *Ignoring Bottom Y*, the bottom left and bottom right Y coordinates are ignored. *Ignoring Bottom X and Y* only checks the locations of the top left and top right coordinates. Values in square brackets represent a 95 % confidence interval after bootstrapping with 1 000 replicates.

Fingers	Standard Scoring	Ignoring Bottom Y	Ignoring Bottom X and Y
Index			
Either	99.3 [99.1, 99.4]	99.5 [99.3, 99.6]	99.6 [99.4, 99.7]
Both	90.6 [90.1, 91.1]	91.6 [91.2, 92.1]	92.3 [91.9, 92.8]
Middle			
Either	99.3 [99.1, 99.4]	99.5 [99.4, 99.6]	99.7 [99.6, 99.8]
Both	90.7 [90.1, 91.1]	92.0 [91.5, 92.5]	93.0 [92.6, 93.5]
Ring			
Either	99.2 [99.0, 99.3]	99.5 [99.4, 99.6]	99.6 [99.5, 99.7]
Both	91.3 [90.8, 91.8]	92.7 [92.3, 93.1]	93.6 [93.1, 94.0]
Little			
Either	99.5 [99.4, 99.6]	99.6 [99.5, 99.7]	99.6 [99.5, 99.7]
Both	92.4 [91.9, 92.9]	93.1 [92.7, 93.6]	93.7 [93.3, 94.1]

Table 26: Percentage of segmentation success by hand for combinations of all eight fingers of a TwoInch slap. In *Ignoring Bottom Y*, the bottom left and bottom right Y coordinates are ignored. *Ignoring Bottom X and Y* only checks the locations of the top left and top right coordinates. Values in square brackets represent a 95 % confidence interval after bootstrapping with 1 000 replicates.

Fingers	Standard Scoring	Ignoring Bottom Y	Ignoring Bottom X and Y
Right			
Any	99.6 [99.5, 99.6]	99.6 [99.5, 99.6]	99.7 [99.7, 99.8]
At Least Two	99.2 [99.0, 99.2]	99.3 [99.1, 99.3]	99.6 [99.5, 99.6]
At Least Three	98.4 [98.0, 98.3]	98.6 [98.3, 98.5]	98.9 [98.8, 99.0]
All Four	92.8 [92.1, 92.6]	94.8 [94.4, 94.8]	95.2 [95.2, 95.6]
Left			
Any	99.5 [99.5, 99.6]	99.6 [99.5, 99.6]	99.8 [99.7, 99.8]
At Least Two	99.1 [99.0, 99.2]	99.1 [99.1, 99.3]	99.6 [99.5, 99.6]
At Least Three	97.8 [98.0, 98.3]	98.2 [98.3, 98.5]	99.0 [98.8, 99.0]
All Four	91.9 [92.1, 92.6]	94.4 [94.4, 94.8]	95.5 [95.2, 95.6]

Table 27: Percentage of segmentation success by hand when only considering combinations of index and middle fingers. In *Ignoring Bottom Y*, the bottom left and bottom right Y coordinates are ignored. *Ignoring Bottom X and Y* only checks the locations of the top left and top right coordinates. Values in square brackets represent a 95 % confidence interval after bootstrapping with 1 000 replicates.

Fingers	Standard Scoring	Ignoring Bottom Y	Ignoring Bottom X and Y
Right			
Either Index or Middle	99.2 [98.9, 99.1]	99.2 [99.0, 99.2]	99.4 [99.4, 99.5]
Both Index and Middle	95.1 [94.7, 95.1]	96.3 [96.0, 96.3]	96.6 [96.7, 97.0]
Left			
Either Index or Middle	98.8 [98.9, 99.1]	98.9 [99.0, 99.2]	99.5 [99.4, 99.5]
Both Index and Middle	94.7 [94.7, 95.1]	96.0 [96.0, 96.3]	97.1 [96.7, 97.0]

Table 28: Percentage of segmentation success by hand when only considering combinations of index, middle, and ring fingers. In *Ignoring Bottom Y*, the bottom left and bottom right Y coordinates are ignored. *Ignoring Bottom X and Y* only checks the locations of the top left and top right coordinates. Values in square brackets represent a 95 % confidence interval after bootstrapping with 1 000 replicates.

Fingers	Standard Scoring	Ignoring Bottom Y	Ignoring Bottom X and Y
Right			
Any	99.4 [99.3, 99.4]	99.4 [99.3, 99.5]	99.7 [99.6, 99.7]
At Least Two	98.6 [98.3, 98.5]	98.8 [98.5, 98.7]	99.1 [99.0, 99.2]
All Three	93.7 [93.1, 93.6]	95.5 [95.1, 95.5]	95.8 [95.8, 96.2]
Left			
Any	99.3 [99.3, 99.4]	99.3 [99.3, 99.5]	99.7 [99.6, 99.7]
At Least Two	98.2 [98.3, 98.5]	98.5 [98.5, 98.7]	99.2 [99.0, 99.2]
All Three	92.9 [93.1, 93.6]	95.1 [95.1, 95.5]	96.2 [95.8, 96.2]

A.2   Jaccard Index

Table 29: For each subject, the percentage that at least *Number of Fingers* fingers were segmented with a Jaccard index in the indicated range.
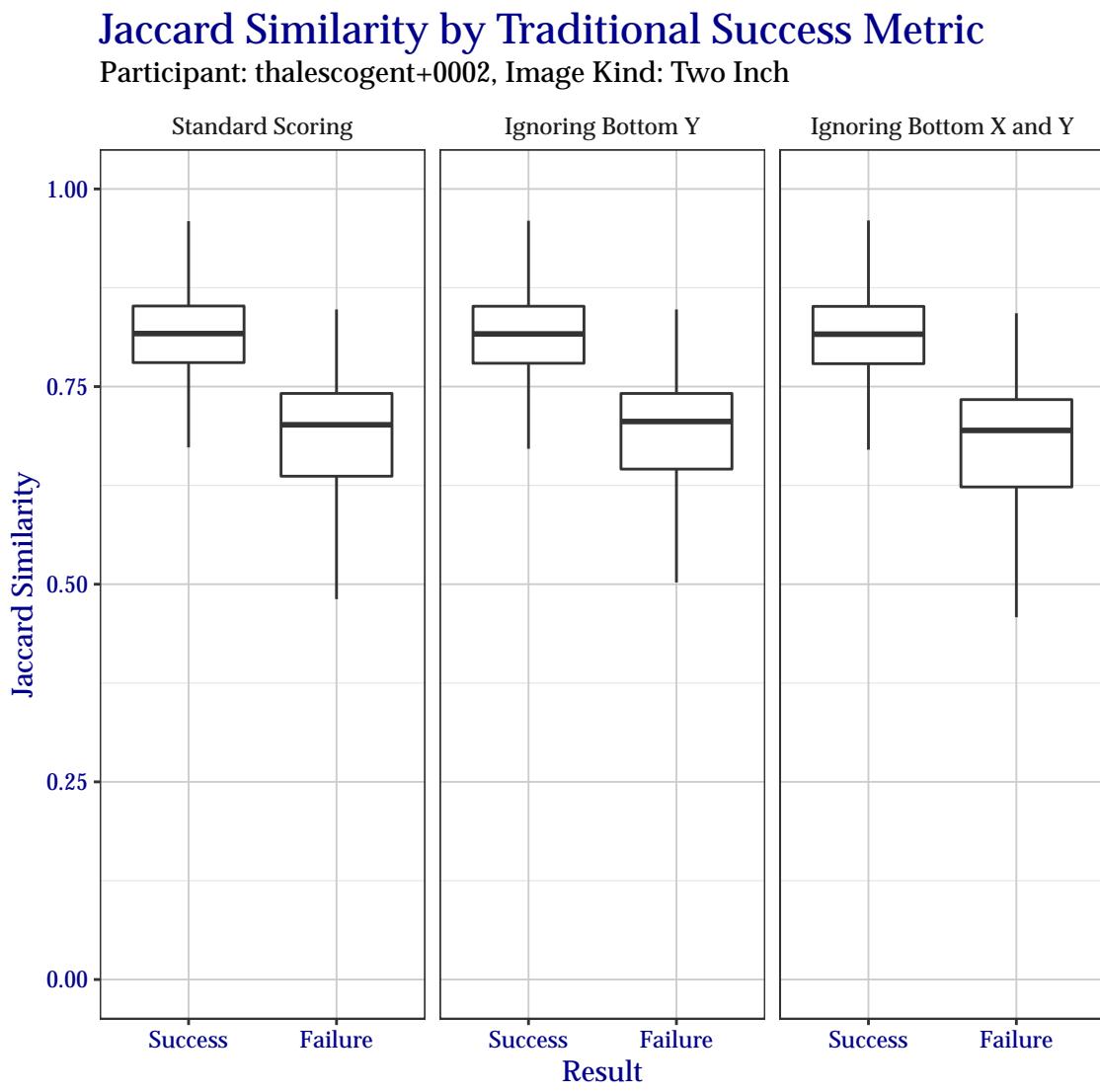
Number of Fingers	≥0.5	≥0.6	≥0.7	≥0.8	≥0.9	≥0.95	≥0.98
1	100.0	100.0	99.9	98.6	27.9	1.7	0.1
2	100.0	100.0	99.9	94.3	9.0	0.1	0.0
3	99.9	99.8	99.5	85.6	2.7	0.0	0.0
4	99.7	99.4	98.5	72.7	0.7	0.0	0.0
5	95.8	95.8	94.5	56.3	0.1	0	0
6	95.8	95.7	92.1	37.9	0.0	0	0
7	95.7	95.1	86.5	20.6	0.0	0	0
8	94.4	90.9	70.1	7.2	0	0	0

Table 30: For all subjects, percentage that a particular friction ridge generalized position was segmented with a Jaccard index in the indicated range.

Finger	0-0.5	0.5-0.6	0.6-0.7	0.7-0.8	0.8-0.9	0.9-1.0
Right						
Index	0.2	0.3	2.6	38.5	53.4	5.0
Middle	0.2	0.4	3.0	31.1	60.1	5.2
Ring	0.2	0.2	2.0	29.3	61.4	6.9
Little	0.2	0.2	1.7	24.5	63.9	9.5
Left						
Index	0.3	0.5	7.2	45.3	45.4	1.3
Middle	0.5	1.1	7.2	39.6	49.4	2.2
Ring	0.2	0.5	4.9	36.2	55.0	3.2
Little	0.4	0.9	4.9	31.9	57.2	4.7

Table 31: Percentage of segmentation obtaining a Jaccard index in the indicated ranges, by hand, for combinations of all eight fingers of a TwoInch slap.

Fingers	≥0.5	≥0.6	≥0.7	≥0.8	≥0.9	≥0.95	≥0.98
Right							
Any	100.0	100.0	99.9	94.5	19.5	1.1	0.0
At Least Two	99.9	99.9	99.7	81.7	5.6	0.1	0.0
At Least Three	99.9	99.8	98.6	59.4	1.3	0.0	0.0
All Four	99.4	98.4	90.5	29.7	0.2	0.0	0.0
Left							
Any	100.0	100.0	99.5	87.5	10.1	0.3	0.0
At Least Two	99.9	99.9	98.0	68.7	1.2	0.0	0.0
At Least Three	99.8	99.5	93.7	44.2	0.1	0.0	0.0
All Four	98.9	96.3	80.2	18.2	0.0	0.0	0.0

Jaccard Similarity by Traditional Success Metric
Participant: thalescogent+0002, Image Kind: Two Inch
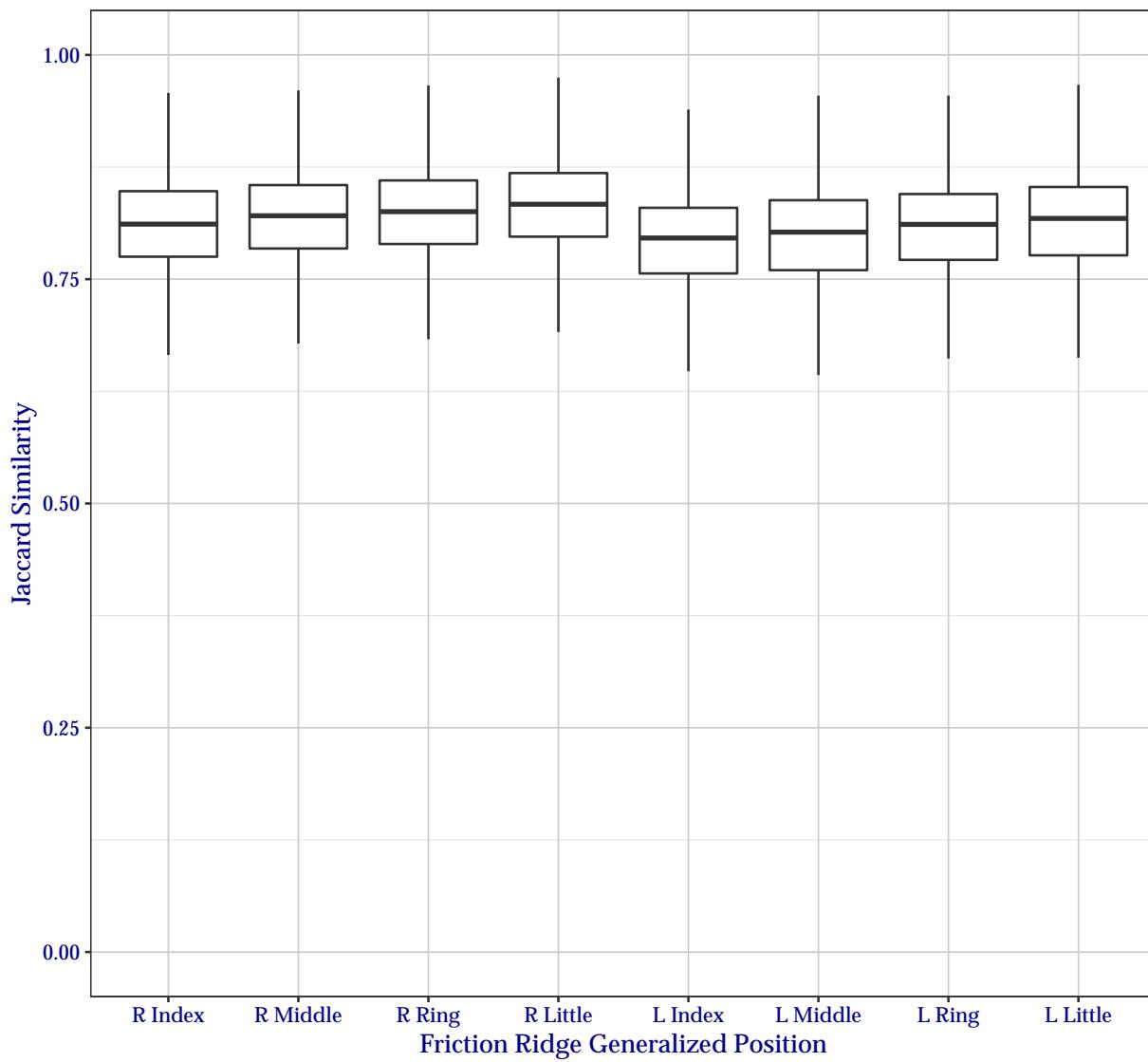
04 September 2020, 03:55:53 PM EDT

Figure 13: Boxplot of Jaccard similarity indices as compared to the traditional success metrics. Outliers have been removed for clarity.

Jaccard Similarity by Friction Ridge Generalized Position

Participant: thalescogent+0002, Image Kind: Two Inch

04 September 2020, 03:55:47 PM EDT

Figure 14: Boxplot of Jaccard similarity indices for each friction ridge generalized position. Outliers have been removed for clarity.

Table 32: Percentage of segmentation obtaining a Jaccard index in the indicated ranges, by hand, for combinations of index and middle fingers of a TwoInch slap.

Fingers	≥0.5	≥0.6	≥0.7	≥0.8	≥0.9	≥0.95	≥0.98
Right							
Either Index or Middle	99.9	99.9	99.6	80.3	9.2	0.4	0.0
Both Index and Middle	99.6	99.0	93.7	43.4	1.0	0.0	0.0
Left							
Either Index or Middle	99.9	99.8	97.4	67.6	3.4	0.1	0.0
Both Index and Middle	99.3	97.8	85.9	30.7	0.1	0	0

Table 33: Percentage of segmentation obtaining a Jaccard index in the indicated ranges, by hand, for combinations of index, middle, and ring fingers of a TwoInch slap.

Fingers	≥0.5	≥0.6	≥0.7	≥0.8	≥0.9	≥0.95	≥0.98
Right							
Any	100.0	99.9	99.8	89.1	13.9	0.7	0.0
At Least Two	99.9	99.8	98.9	67.6	2.9	0.0	0.0
All Three	99.5	98.8	92.2	35.3	0.3	0.0	0.0
Left							
Any	100.0	99.9	98.8	79.1	6.2	0.2	0.0
At Least Two	99.9	99.6	95.3	53.6	0.5	0.0	0.0
All Three	99.2	97.4	83.5	23.8	0.0	0	0

B   Identification Flats ("ThreeInch" Data)

B.1   Bootstrap Confidence for Segmentation Statistics

This section shows the same detailed results of segmentation of ThreeInch data from Section 3.3, but with an added bootstrap confidence interval. For each observation, a bootstrap routine with 1 000 replicates was run, and a 95 % confidence interval extracted. The lower and upper confidence from that confidence interval are printed in each column within square brackets.

In Table 34, results are shown of how successful thalescogent+0002 segmented fingers for each subject in the test corpus. Table 35 shows success for specific finger positions over the entire test corpus. Similarly, Table 36 shows success for segmenting the same finger position from both hands.

The remainder of the tables show success per subject when considering combinations of subsets of the fingers in each slap image. Table 37 shows success for combinations of all fingers, Table 39 for the all except the little finger, and Table 38 for just the index and middle fingers.

Table 34: For each subject, the percentage that at least *Number of Fingers* fingers were correctly segmented, regardless of hand, for a maximum of eight correctly-segmented fingers. In *Standard Scoring*, scoring rules are followed exactly. In *Ignoring Bottom Y*, the bottom left and bottom right Y coordinates are ignored. *Ignoring Bottom X and Y* only checks the locations of the top left and top right coordinates. Values in square brackets represent a 95 % confidence interval after bootstrapping with 1 000 replicates.

Number of Fingers	Standard Scoring	Ignoring Bottom Y	Ignoring Bottom X and Y
1	100.0 [99.9, 100.0]	100.0 [99.9, 100.0]	100.0 [99.9, 100.0]
2	99.8 [99.8, 99.9]	99.8 [99.8, 99.9]	99.9 [99.8, 99.9]
3	98.5 [98.4, 98.7]	98.5 [98.4, 98.7]	98.6 [98.4, 98.7]
4	98.2 [98.0, 98.4]	98.3 [98.1, 98.4]	98.3 [98.2, 98.5]
5	95.9 [95.7, 96.1]	95.9 [95.7, 96.2]	95.9 [95.7, 96.2]
6	95.9 [95.6, 96.1]	95.9 [95.7, 96.1]	95.9 [95.7, 96.2]
7	95.8 [95.6, 96.1]	95.9 [95.6, 96.1]	95.9 [95.6, 96.1]
8	95.6 [95.4, 95.9]	95.7 [95.5, 96.0]	95.8 [95.6, 96.1]
9	94.3 [94.0, 94.6]	94.8 [94.5, 95.1]	95.5 [95.2, 95.7]
10	86.2 [85.8, 86.6]	88.7 [88.3, 89.1]	92.2 [91.8, 92.5]

Table 35: For all subjects, Percentage that a particular friction ridge generalized position was correctly segmented. In *Ignoring Bottom Y*, the bottom left and bottom right Y coordinates are ignored. *Ignoring Bottom X and Y* only checks the locations of the top left and top right coordinates. Values in square brackets represent a 95 % confidence interval after bootstrapping with 1 000 replicates.

Finger	Standard Scoring	Ignoring Bottom Y	Ignoring Bottom X and Y
Right			
Thumb	98.1 [97.9, 98.3]	98.5 [98.3, 98.6]	99.3 [99.2, 99.4]
Index	99.2 [99.1, 99.3]	99.5 [99.4, 99.6]	99.6 [99.5, 99.7]
Middle	98.8 [98.7, 98.9]	99.3 [99.2, 99.4]	99.7 [99.6, 99.7]
Ring	98.4 [98.2, 98.5]	98.9 [98.8, 99.0]	99.6 [99.6, 99.7]
Little	98.7 [98.5, 98.8]	98.9 [98.7, 99.0]	99.2 [99.1, 99.3]
Left			
Thumb	98.2 [98.0, 98.4]	98.6 [98.5, 98.8]	99.3 [99.2, 99.4]
Index	99.1 [98.9, 99.2]	99.2 [99.1, 99.3]	99.4 [99.3, 99.5]
Middle	98.8 [98.7, 99.0]	99.2 [99.1, 99.3]	99.6 [99.6, 99.7]
Ring	98.7 [98.5, 98.8]	98.9 [98.8, 99.0]	99.7 [99.6, 99.8]
Little	98.9 [98.7, 99.0]	99.1 [98.9, 99.2]	99.3 [99.2, 99.4]

Table 36: Percentage that a particular type of fingerprint was correctly segmented on *Either* or *Both* hands. In *Ignoring Bottom Y*, the bottom left and bottom right Y coordinates are ignored. *Ignoring Bottom X and Y* only checks the locations of the top left and top right coordinates. Values in square brackets represent a 95 % confidence interval after bootstrapping with 1 000 replicates.

Fingers	Standard Scoring	Ignoring Bottom Y	Ignoring Bottom X and Y
Thumb			
Either	99.6 [99.5, 99.7]	99.7 [99.6, 99.8]	99.9 [99.8, 99.9]
Both	96.8 [96.5, 97.0]	97.5 [97.3, 97.7]	98.8 [98.7, 99.0]
Index			
Either	99.9 [99.8, 99.9]	99.9 [99.8, 99.9]	99.9 [99.9, 99.9]
Both	95.7 [95.5, 96.0]	96.1 [95.9, 96.3]	96.4 [96.1, 96.6]
Middle			
Either	99.7 [99.6, 99.8]	99.8 [99.7, 99.9]	99.9 [99.8, 99.9]
Both	95.3 [95.0, 95.5]	96.0 [95.8, 96.3]	96.7 [96.5, 96.9]
Ring			
Either	99.8 [99.7, 99.8]	99.8 [99.7, 99.8]	99.9 [99.9, 99.9]
Both	94.6 [94.3, 94.9]	95.3 [95.1, 95.6]	96.7 [96.5, 96.9]
Little			
Either	99.7 [99.6, 99.8]	99.7 [99.7, 99.8]	99.8 [99.7, 99.8]
Both	95.2 [94.9, 95.4]	95.5 [95.2, 95.8]	96.1 [95.8, 96.3]

Table 37: Percentage of segmentation success by hand for combinations of all ten fingers of a ThreeInch slap. In *Ignoring Bottom Y*, the bottom left and bottom right Y coordinates are ignored. *Ignoring Bottom X and Y* only checks the locations of the top left and top right coordinates. Values in square brackets represent a 95 % confidence interval after bootstrapping with 1 000 replicates.

Fingers	Standard Scoring	Ignoring Bottom Y	Ignoring Bottom X and Y
Right			
Any	99.9 [99.8, 99.9]	99.9 [99.9, 99.9]	99.9 [99.9, 99.9]
At Least Two	98.5 [98.4, 98.6]	98.5 [98.4, 98.6]	98.5 [98.4, 98.6]
At Least Three	98.4 [98.3, 98.5]	98.5 [98.3, 98.6]	98.5 [98.4, 98.6]
At Least Four	97.8 [97.6, 97.9]	98.1 [97.9, 98.1]	98.3 [98.1, 98.3]
All Five	89.4 [89.4, 89.9]	90.9 [90.8, 91.3]	93.0 [92.8, 93.2]
Left			
Any	99.9 [99.8, 99.9]	99.9 [99.9, 99.9]	99.9 [99.9, 99.9]
At Least Two	98.5 [98.4, 98.6]	98.5 [98.4, 98.6]	98.5 [98.4, 98.6]
At Least Three	98.4 [98.3, 98.5]	98.4 [98.3, 98.6]	98.5 [98.4, 98.6]
At Least Four	97.7 [97.6, 97.9]	97.9 [97.9, 98.1]	98.2 [98.1, 98.3]
All Five	89.9 [89.4, 89.9]	91.1 [90.8, 91.3]	93.0 [92.8, 93.2]

Table 38: Percentage of segmentation success by hand when only considering combinations of index and middle fingers. In *Ignoring Bottom Y*, the bottom left and bottom right Y coordinates are ignored. *Ignoring Bottom X and Y* only checks the locations of the top left and top right coordinates. Values in square brackets represent a 95 % confidence interval after bootstrapping with 1 000 replicates.

Fingers	Standard Scoring	Ignoring Bottom Y	Ignoring Bottom X and Y
Right			
Either Index or Middle	99.9 [99.9, 99.9]	99.9 [99.9, 99.9]	100.0 [99.9, 100.0]
Both Index and Middle	98.1 [98.0, 98.2]	98.9 [98.6, 98.8]	99.3 [99.1, 99.3]
Left			
Either Index or Middle	99.9 [99.9, 99.9]	99.9 [99.9, 99.9]	99.9 [99.9, 100.0]
Both Index and Middle	98.0 [98.0, 98.2]	98.5 [98.6, 98.8]	99.1 [99.1, 99.3]

Table 39: Percentage of segmentation success by hand when only considering combinations of index, middle, and ring fingers. In *Ignoring Bottom Y*, the bottom left and bottom right Y coordinates are ignored. *Ignoring Bottom X and Y* only checks the locations of the top left and top right coordinates. Values in square brackets represent a 95 % confidence interval after bootstrapping with 1 000 replicates.

| Fingers	Standard Scoring	Ignoring Bottom Y	Ignoring Bottom X and Y
Right			
Any	99.9 [99.9, 100.0]	100.0 [99.9, 100.0]	100.0 [99.9, 100.0]
At Least Two	99.7 [99.7, 99.8]	99.8 [99.8, 99.9]	99.9 [99.9, 99.9]
All Three	96.7 [96.6, 96.9]	97.9 [97.6, 97.9]	99.0 [98.8, 99.0]
Left			
Any	100.0 [99.9, 100.0]	100.0 [99.9, 100.0]	100.0 [99.9, 100.0]
At Least Two	99.8 [99.7, 99.8]	99.8 [99.8, 99.9]	99.9 [99.9, 99.9]
All Three	96.8 [96.6, 96.9]	97.6 [97.6, 97.9]	98.9 [98.8, 99.0]
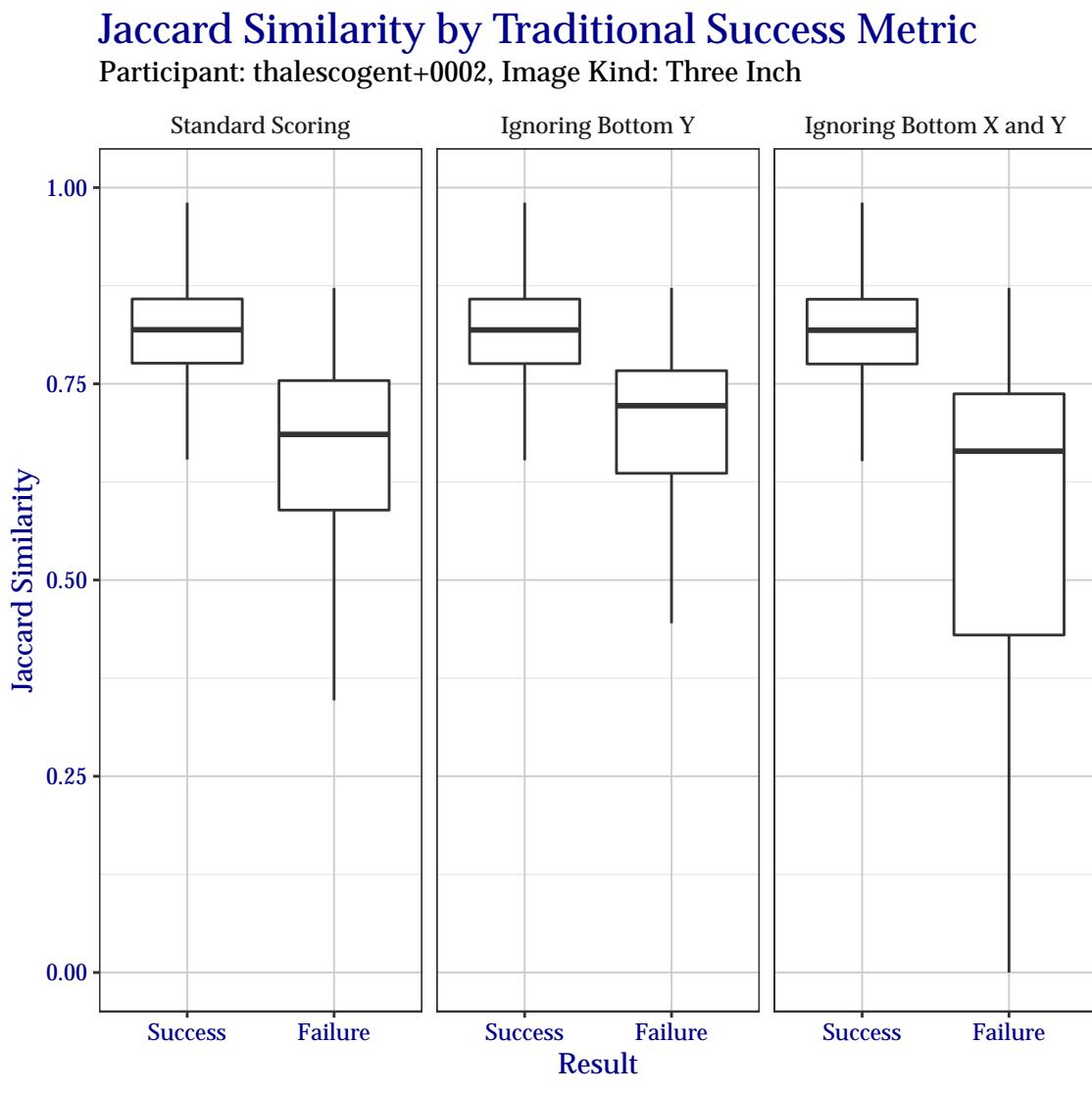
B.2   Jaccard Index

Table 40: For each subject, the percentage that at least *Number of Fingers* fingers were segmented with a Jaccard index in the indicated range.

| Number of Fingers	≥0.5	≥0.6	≥0.7	≥0.8	≥0.9	≥0.95	≥0.98
1	100.0	100.0	99.9	98.5	46.4	4.5	0.3
2	100.0	100.0	99.7	96.1	17.2	0.2	0.0
3	98.6	98.5	97.9	91.3	5.4	0.0	0.0
4	98.4	98.3	97.2	84.6	1.5	0.0	0.0
5	95.9	95.9	95.7	74.1	0.3	0	0
6	95.9	95.9	95.3	60.8	0.0	0	0
7	95.9	95.9	93.5	45.3	0.0	0	0
8	95.9	95.7	90.3	28.9	0	0	0
9	95.7	95.1	84.1	14.5	0	0	0
10	94.9	92.0	67.8	4.4	0	0	0

Table 41: For all subjects, percentage that a particular friction ridge generalized position was segmented with a Jaccard index in the indicated range.

Finger	0-0.5	0.5-0.6	0.6-0.7	0.7-0.8	0.8-0.9	0.9-1.0
Right						
Thumb	0.2	0.1	2.3	42.8	51.4	3.2
Index	0.2	0.4	4.6	28.5	58.7	7.6
Middle	0.1	0.7	6.3	32.4	54.1	6.4
Ring	0.1	0.8	6.8	35.4	51.5	5.4
Little	0.2	0.6	4.2	23.6	57.7	13.7
Left						
Thumb	0.3	0.2	2.2	39.2	54.5	3.6
Index	0.1	0.2	4.3	32.7	55.3	7.4
Middle	0.2	0.4	6.1	36.3	50.2	6.8
Ring	0.1	0.3	6.9	35.1	51.1	6.5
Little	0.3	0.4	4.0	27.0	56.1	12.2

Jaccard Similarity by Traditional Success Metric
Participant: thalescogent+0002, Image Kind: Three Inch
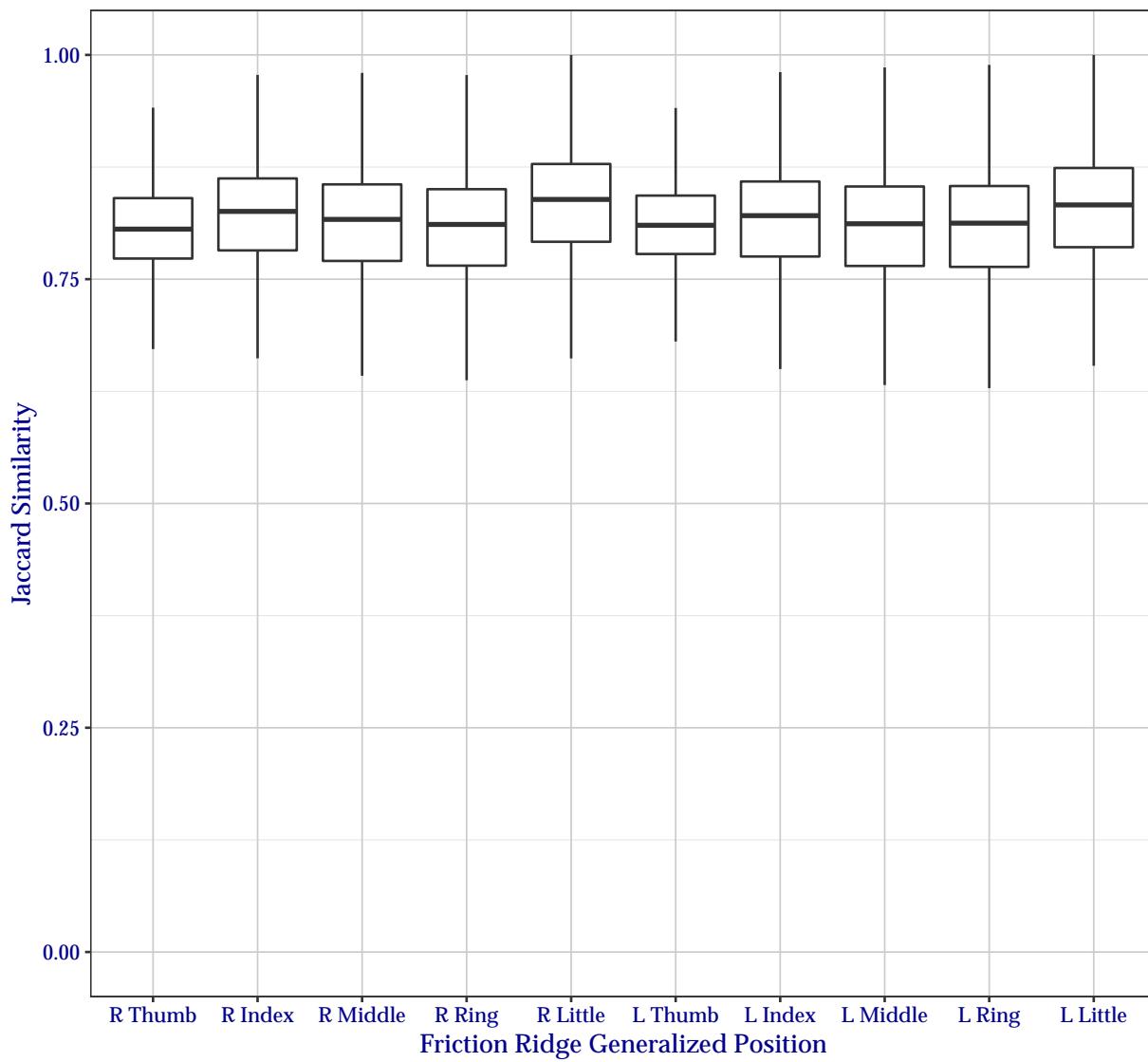
04 September 2020, 04:00:23 PM EDT

Figure 15: Boxplot of Jaccard similarity indices as compared to the traditional success metrics. Outliers have been removed for clarity.

Jaccard Similarity by Friction Ridge Generalized Position
Participant: thalescogent+0002, Image Kind: Three Inch

04 September 2020, 04:00:14 PM EDT

Figure 16: Boxplot of Jaccard similarity indices for each friction ridge generalized position. Outliers have been removed for clarity.

Table 42: Percentage of segmentation obtaining a Jaccard index in the indicated ranges, by hand, for combinations of all ten fingers of a ThreeInch slap.

Fingers	≥0.5	≥0.6	≥0.7	≥0.8	≥0.9	≥0.95	≥0.98
Right							
Any	100.0	100.0	99.8	95.4	28.5	2.1	0.2
At Least Two	98.5	98.5	97.3	82.9	6.2	0.1	0.0
At Least Three	98.5	98.3	95.4	67.0	0.9	0.0	0.0
At Least Four	98.4	97.8	91.8	43.5	0.1	0.0	0.0
All Five	94.5	92.6	79.2	15.3	0.0	0.0	0.0
Left							
Any	100.0	99.9	99.9	95.5	28.4	2.5	0.2
At Least Two	98.5	98.5	98.0	81.7	6.3	0.1	0.0
At Least Three	98.5	98.4	96.4	64.4	1.0	0.0	0.0
At Least Four	98.3	98.1	92.6	41.4	0.1	0.0	0.0
All Five	94.4	93.2	78.3	15.2	0.0	0.0	0.0

Table 43: Percentage of segmentation obtaining a Jaccard index in the indicated ranges, by hand, for combinations of index and middle fingers of a ThreeInch slap.

Fingers	≥0.5	≥0.6	≥0.7	≥0.8	≥0.9	≥0.95	≥0.98
Right							
Either Index or Middle	100.0	99.8	97.2	78.7	12.7	0.9	0.0
Both Index and Middle	99.7	98.7	90.5	48.1	1.3	0.0	0.0
Left							
Either Index or Middle	100.0	99.9	98.2	76.1	12.9	0.9	0.0
Both Index and Middle	99.7	99.2	90.6	43.7	1.4	0.0	0.0

Table 44: Percentage of segmentation obtaining a Jaccard index in the indicated ranges, by hand, for combinations of index, middle, and ring fingers of a ThreeInch slap.

Fingers	≥0.5	≥0.6	≥0.7	≥0.8	≥0.9	≥0.95	≥0.98
Right							
Any	100.0	99.9	98.0	83.7	16.5	1.1	0.1
At Least Two	99.9	99.6	95.0	64.5	2.7	0.0	0.0
All Three	99.6	98.1	86.9	35.5	0.2	0.0	0.0
Left							
Any	100.0	100.0	99.0	82.5	17.3	1.3	0.1
At Least Two	99.9	99.8	96.2	61.4	3.1	0.0	0.0
All Three	99.6	98.9	86.3	33.4	0.3	0	0