

NISTIR 8257

Nail to Nail Fingerprint Challenge

Enrollment Set Variability

Gregory Fiumara

Kenneth Ko

Elham Tabassi

Patricia Flanagan

John Grantham

Karen Marshall

Matthew Schwarz

Bryan Woodgate

This publication is available free of charge from:
<https://doi.org/10.6028/NIST.IR.8257>

NIST
National Institute of
Standards and Technology
U.S. Department of Commerce

NISTIR 8257

Nail to Nail Fingerprint Challenge

Enrollment Set Variability

Gregory Fiumara

Kenneth Ko

Elham Tabassi

Patricia Flanagan

Karen Marshall

Bryan Woodgate

Information Access Division

Information Technology Laboratory

John Grantham

Systems Plus, Inc.

Matthew Schwarz

Schwarz Forensic Enterprises

This publication is available free of charge from:
<https://doi.org/10.6028/NIST.IR.8257>

June 2019



U.S. Department of Commerce
Wilbur L. Ross, Jr., Secretary

National Institute of Standards and Technology
Walter Copan, NIST Director and Undersecretary of Commerce for Standards and Technology

Certain commercial entities, equipment, or materials may be identified in this document in order to describe an experimental procedure or concept adequately. Such identification is not intended to imply recommendation or endorsement by the National Institute of Standards and Technology, nor is it intended to imply that the entities, materials, or equipment are necessarily the best available for the purpose.

**National Institute of Standards and Technology Interagency or Internal Report 8257
Natl. Inst. Stand. Technol. Interag. Intern. Rep. 8257, 16 pages (June 2019)**

**This publication is available free of charge from:
<https://doi.org/10.6028/NIST.IR.8257>**

Abstract

In September 2017, the Intelligence Advanced Research Projects Activity held a fingerprint data collection as part of the Nail to Nail Fingerprint Challenge. Thousands of latent fingerprint images collected at the Challenge were searched against rolled-equivalent fingerprints with an automated friction ridge identification system. These searches yielded poor results. It was hypothesized that the size of the enrollment set might be to blame for the weak performance. This supplemental report varied the size of the enrollment set to test the hypothesis.

Key words

acquisition; biometrics; capture devices; data; fingerprints; latent; prototypes; rolled; sensors.

Disclaimer

Certain commercial equipment, instruments, or materials are identified in this document in order to specify the development procedure adequately. Such identification is not intended to imply recommendation or endorsement by the National Institute of Standards and Technology, nor is it intended to imply that the materials or equipment identified are necessarily the best available for the purpose.

Table of Contents

1	Introduction	1
2	Methodology	2
3	Latent Identification	3
4	Nail to Nail Identification	5
5	Special Database 302	6
	References	9

List of Tables

1	Latent Identification — False Negative Identification Rate at a False Positive Identification Rate of 10^{-1}	3
2	Latent Identification — Cumulative Match Characteristic — Ranks 1 and 10	4
3	Nail to Nail Identification — False Negative Identification Rate at a False Positive Identification Rate of 10^{-1}	5
4	Nail to Nail Identification — Cumulative Match Characteristic — Rank 1	5
5	Special Database 302 — Latent Identification — False Negative Identification Rate at a False Positive Identification Rate of 10^{-1}	6
6	Special Database 302 — Latent Identification — Cumulative Match Characteristic — Ranks 1 and 10	6
7	Special Database 302 — Nail to Nail Identification — False Negative Identification Rate at a False Positive Identification Rate of 10^{-1}	7
8	Special Database 302 — Nail to Nail Identification — Cumulative Match Characteristic — Rank 1	7

Executive Summary

Overview The National Institute of Standards and Technology (NIST) conducted data analysis on fingerprint images acquired during the fingerprint data collection portion of the Nail to Nail Fingerprint Challenge¹, an Intelligence Advanced Research Projects Activity (IARPA) Prize Challenge. The results of the Nail to Nail Fingerprint Challenge were published in NISTIR 8210 [1]. That report showed latent identification accuracy to be quite poor, which deviated from NIST's previously published studies of automated latent friction ridge identification technologies [2]. NISTIR 8210 proposed reducing the number of subjects in the MATCHER's enrollment sets to investigate if the large number of subjects was the cause of the unsatisfactory results. This supplemental brief reports on such an investigation.

Results Latent identifications were searched against enrollment sets with 3 000 000, 1 500 000, and 100 000 subjects. For all Challengers, no significantly measurable difference in accuracy was seen (<1%) over a nearly 97% reduction in enrollment set size. The MATCHER likely compares search images to every image in the enrollment set, regardless of enrollment set size.

Nail to nail searches were also performed against enrollment set sizes of 3 000 000, 1 500 000, 300 000, and 30 000 subjects. Accuracy marginally improved for all Challengers. In the baseline case, when the enrollment set was reduced by 90%, False Negative Identification Rate (FNIR) improved 28%, and Rank 1 hit rate increased nearly 3 percentage points.

Impact Despite a dramatic reduction in enrollment set size, automated latent friction ridge identification accuracy with the MATCHER remains poor. This seems to indicate that the search data is challenging. More studies of automated latent friction ridge identification technologies should be performed with this and similar challenging data. NIST has released a large portion of the imagery from this study to the research community to spur this effort.

Additionally, the affect that Extended Feature Set (EFS) features have on automated latent friction ridge identifications of challenging data should be explored. NIST plans to fund an effort to have Certified Latent Print Examiners (CLPEs) annotate the latent images used in this study. The EFS data recorded can then be used by the MATCHER during search to aid in decision-making.

¹<https://challenge.gov/challenge/nail-to-nail-n2n-fingerprint-challenge>

1. Introduction

The Intelligence Advanced Research Projects Activity (IARPA) held a data collection as part of their Nail to Nail Fingerprint Challenge in September 2017. The Challenge aimed to identify nail to nail (N2N) fingerprint capture devices that could support high-quality live N2N capture without requiring the physical intervention of a human operator to roll a subject’s finger. During this data collection, thousands of latent friction ridge images were collected from study participants.

The Nail to Nail Fingerprint Challenge included a prize—the *Latent Accuracy Prize*—for the the best accuracy when searching latent fingerprint images against an enrollment set seeded with images created by each Challenger’s device. Challengers were given the opportunity to provide their own latent fingerprint matching algorithms, but all declined. Instead, the National Institute of Standards and Technology (NIST)-provided Fingerprint Identification Algorithm (MATCHER) was used. In the analysis of the Latent Accuracy Prize, *NISTIR 8210: Nail to Nail Fingerprint Challenge — Prize Analysis* [1], it was noted that the overall automated latent identification performance for the Nail to Nail Fingerprint Challenge was quite poor. These results did not line up with what was expected, as gleaned from prior NIST studies such as *Evaluation of Latent Fingerprint Technologies: Extended Feature Sets (ELFT-EFS)* [2]. It was put forward to test the MATCHER with a smaller number of subjects available in the enrollment set. The results of such a test are reported here, as well as a similar test performed when searching Challenger N2N images.

NIST additionally prepared a research dataset of images from the Nail to Nail Fingerprint Challenge, *Special Database (SD) 302*. Results for searching only those images provided as part of SD 302 against each enrollment set size variation are additionally provided.

2. Methodology

The data collection at the Nail to Nail Fingerprint Challenge consisted of 331 study participants. Each study participant had all 10 fingers available to be imaged. They visited each Challenger's collection station for 5 minutes. The study participant's individual fingers were enrolled in the MATCHER as separate subjects (a total of 3310 possible mated enrolled subjects) as a simple way to enforce that both the correct study participant and correct finger position were selected. More detailed information about experiment methodology can be reviewed in Section 8 of NISTIR 8210.

2.1 Latent Identification

As required by the Latent Accuracy Prize, the enrollment set for latent identification was first populated with 1 to 10 operationally-collected law enforcement rolled fingerprint images from $\approx 3\,000\,000$ subjects, for a total of 29 982 781 non-mated fingerprint images. Non-mated searches of latent distal phalanx images were performed. At the completion of the non-mated searches, individual fingerprint images from each N2N study participant were enrolled as a separate subjects in the enrollment set, for a total of up to 3 003 309 subject identifiers and 29 986 091 fingers in the enrollment set. Each Challenger had their own enrollment set, featuring the same $\approx 3\,000\,000$ non-mated subjects and up to 3310 mated subjects, depending on the Challenger's failure to acquire rate.

The number of subjects in the enrollment sets was then reduced to 1 500 000 subjects, and 100 000 subjects, each time by randomly removing subjects from the next largest enrollment set.

2.1.1 Latent Search Size

The analysis in NISTIR 8210 had 62 721 latent distal phalanx latent images available for searching. Since publication, Certified Latent Print Examiners (CLPEs) working on N2N latent development and digitization processed more latents from the artifacts collected during the Nail to Nail Fingerprint Challenge. This resulted in the production of 27 643 additional latent distal phalanx images suitable for searching, for a grand total 90 364 searches to be performed per Challenger per enrollment set. Values in this report are all based on this larger search size.

2.2 Nail to Nail Identification

As required by the *Gallery Accuracy Prize*, the enrollment set for the N2N identification was first populated with 1 to 10 operationally-collected law enforcement rolled fingerprint images from $\approx 3\,000\,000$ subjects, for a total of 29 982 781 non-mated fingerprint images. This enrollment set was augmented with the 10 Baseline Data finger images collected from each of the 331 study participants during the Nail to Nail Fingerprint Challenge.

The number of subjects in the enrollment sets was then reduced to 1 500 000 subjects, 300 000 subjects, and 30 000 subjects, each time by randomly removing subjects from the subsequently larger enrollment set.

Challenger	FNIR @ FPIR = 10^{-1} — Enrolled Subjects		
	100 000	1 500 000	3 000 000
Ω	0.900 \pm 0.001	0.906 \pm 0.001	0.908 \pm 0.001
A	² 0.906 \pm 0.001	³ 0.914 \pm 0.001	³ 0.915 \pm 0.001
B	⁴ 0.915 \pm 0.001	⁴ 0.922 \pm 0.001	⁴ 0.924 \pm 0.001
C	¹ 0.893 \pm 0.001	¹ 0.899 \pm 0.001	¹ 0.901 \pm 0.001
D	⁷ 0.976 \pm 0.0006	⁷ 0.981 \pm 0.0005	⁷ 0.981 \pm 0.0005
E	³ 0.907 \pm 0.001	² 0.913 \pm 0.001	² 0.914 \pm 0.001
F	⁵ 0.935 \pm 0.001	⁵ 0.941 \pm 0.0009	⁵ 0.942 \pm 0.0009
G	⁶ 0.976 \pm 0.0006	⁶ 0.977 \pm 0.0006	⁶ 0.978 \pm 0.0006
H	⁸ 1.000 \pm 0.00001	⁸ 1.000 \pm 0.000007	⁸ 1.000 \pm 0.000007

Table 1. Values for FNIR at a fixed FPIR of 10^{-1} for the same latent distal phalanx identifications over different size enrollment sets. Each column represents a different number of enrolled subjects in the enrollment set. The Baseline Data is recorded in blue. The best non-baseline value is reported in green and the worst in red. Challenger values that meet or beat the baseline are shaded in blue. Superscript numbers preceding the FNIR value represent its ranking in each column. The confidence intervals depicted are a 90% Wilson confidence interval [4].

3. Latent Identification

After publication of NISTIR 8210, latent development and digitization continued. As a result, several more latent images were available for searching (detailed in Section 2.1.1).

Latent search results conducted in NISTIR 8210 were first augmented with the results of searching the additional latent images digitized since publication over an enrollment set of 3 000 000 subjects. To investigate the affect of enrollment set size, the enrollment set was reduced to 1 500 000 subjects and all searches were repeated. Several smaller increments were planned, but because no substantial improvement was noticed when reducing the enrollment set by 50 %, the searches were repeated with the smallest planned enrollment set size, 100 000 subjects.

False Negative Identification Rate (FNIR) values recorded at the Nail to Nail Fingerprint Challenge’s fixed False Positive Identification Rate (FPIR) figure of merit are shown in Table 1. Cumulative Match Characteristic (CMC) values showing hit rate percentage at Rank 1 are shown in Table 2. Each row contains results for each of the enrollment set size variations tested.

3.1 Discussion

- Despite several thousand additional searches, there are no changes to Challenger rankings.
- Accuracy is largely unchanged, regardless of enrollment set size.

3.2 Next Steps

The latent data collected in the Nail to Nail Fingerprint Challenge appears to be extremely difficult to reliably match. NIST plans to fund an effort for CLPEs to annotate as much of the data as possible, using Extended Feature Set (EFS) Profile 2 [3]. The hope is that in providing hints from CLPEs, the MATCHER will be able to more accurately determine the source of the latent mark.

Challenger	Enrolled Subjects					
	100 000		1 500 000		3 000 000	
	$R = 1$	$R = 10$	$R = 1$	$R = 10$	$R = 1$	$R = 10$
Ω	10.5	11.1	9.7	10.3	9.5	10.2
A	² 10.0	² 10.7	² 9.0	² 9.8	³ 8.8	² 9.6
B	⁴ 9.1	⁴ 9.8	⁴ 8.2	⁴ 8.9	⁴ 8.0	⁴ 8.8
C	¹ 11.3	¹ 11.9	¹ 10.5	¹ 11.1	¹ 10.3	¹ 11.0
D	⁶ 2.6	⁶ 3.0	⁷ 2.1	⁷ 2.5	⁷ 2.0	⁷ 2.5
E	³ 9.8	³ 10.5	³ 9.0	³ 9.7	² 8.9	³ 9.5
F	⁵ 6.9	⁵ 7.3	⁵ 6.2	⁵ 6.7	⁵ 6.0	⁵ 6.6
G	⁷ 2.6	⁷ 2.7	⁶ 2.3	⁶ 2.5	⁶ 2.3	⁶ 2.5
H	⁸ 0.0	⁸ 0.0	⁸ 0.0	⁸ 0.0	⁸ 0.0	⁸ 0.0

Table 2. Hit rate percentages for Ranks 1 ($R = 1$) and 10 ($R = 10$) when searching all study participant latent distal phalanx images against enrollment sets with various numbers of enrolled subjects. Each column group represents a different number of enrolled subjects in the enrollment set. The Baseline Data is recorded in blue. The best non-baseline value is reported in green and the worst in red. Challenger values that meet or beat the baseline are shaded in blue. Superscript numbers preceding the hit rate value represent its ranking in each column.

Challenger	FNIR @ FPIR = 10 ⁻¹ — Enrolled Subjects			
	30 000	300 000	1 500 000	3 000 000
Ω	0.063 ± 0.005	0.078 ± 0.005	0.085 ± 0.006	0.088 ± 0.006
A	³ 0.174 ± 0.008	³ 0.201 ± 0.008	³ 0.210 ± 0.008	³ 0.214 ± 0.008
B	⁵ 0.235 ± 0.009	⁵ 0.268 ± 0.009	⁵ 0.277 ± 0.009	⁵ 0.279 ± 0.009
C	¹ 0.071 ± 0.005	¹ 0.091 ± 0.006	¹ 0.097 ± 0.006	¹ 0.098 ± 0.006
D	⁶ 0.690 ± 0.009	⁷ 0.792 ± 0.008	⁷ 0.820 ± 0.008	⁷ 0.824 ± 0.008
E	² 0.160 ± 0.007	² 0.184 ± 0.008	² 0.194 ± 0.008	² 0.198 ± 0.008
F	⁴ 0.187 ± 0.008	⁴ 0.220 ± 0.008	⁴ 0.231 ± 0.009	⁴ 0.235 ± 0.009
G	⁷ 0.712 ± 0.009	⁶ 0.721 ± 0.009	⁶ 0.723 ± 0.009	⁶ 0.724 ± 0.009
H	⁸ 1.000 ± 0.0002	⁸ 1.000 ± 0.0002	⁸ 1.000 ± 0.0002	⁸ 1.000 ± 0.0002

Table 3. Values for FNIR at a FPIR of 10⁻¹ when searching ≤3 310 Challenger N2N images from SD 302 against enrollment sets with different numbers of enrolled subjects. Each column represents a different number of enrolled subjects in the enrollment set. The Baseline Data is recorded in blue. The best non-baseline value is reported in green and the worst in red. Challenger values that meet or beat the baseline are shaded in blue. Superscript numbers preceding the FNIR value represent its ranking in each column. The confidence intervals depicted are a 90% Wilson confidence interval [4].

Challenger	Hit Rate (Rank 1) — Enrolled Subjects			
	30 000	300 000	1 500 000	3 000 000
Ω	93.8	92.2	91.5	91.2
A	³ 82.7	³ 79.9	³ 79.0	³ 78.6
B	⁵ 76.6	⁵ 73.2	⁵ 72.3	⁵ 72.1
C	¹ 93.0	¹ 90.9	¹ 90.3	¹ 90.2
D	⁶ 31.4	⁷ 20.9	⁷ 18.0	⁷ 17.6
E	² 84.1	² 81.7	² 80.7	² 80.4
F	⁴ 81.4	⁴ 78.1	⁴ 77.0	⁴ 76.6
G	⁷ 28.9	⁶ 27.9	⁶ 27.7	⁶ 27.6
H	⁸ 0.0	⁸ 0.0	⁸ 0.0	⁸ 0.0

Table 4. Hit rate percentages for Rank 1 when searching ≤3 310 Challenger N2N images against enrollment sets with different numbers of enrolled subjects. Each column represents a different number of enrolled subjects in the enrollment set. The Baseline Data is recorded in blue. The best non-baseline value is reported in green and the worst in red. Challenger values that meet or beat the baseline are shaded in blue. Superscript numbers preceding the hit rate value represent its ranking in each column.

4. Nail to Nail Identification

The primary investigatory purpose of this supplemental report was to determine if the number of subjects in enrollment set was the reason for poor latent friction ridge identification accuracy. While the original published results for N2N identification were not out of line, a test of enrollment set size variation was performed.

FNIR values recorded at the Nail to Nail Fingerprint Challenge’s fixed FPIR figure of merit are shown in Table 3. CMC values showing hit rate percentage at Rank 1 are shown in Table 4. Each row contains results for each of the enrollment set size variations tested. Values in the enrollment set size column for 3 000 000 were originally published in NISTIR 8210.

4.1 Discussion

- Reduction in enrollment set size benefits all Challengers except H.
- Baseline Data continues to outperform all Challengers at any enrollment set size.

This publication is available free of charge from: <https://doi.org/10.6028/NIST.IR.8257>

Challenger	FNIR @ FPIR = 10^{-1} — Enrolled Subjects		
	100 000	1 500 000	3 000 000
Ω	0.916 \pm 0.003	0.922 \pm 0.003	0.924 \pm 0.003
A	³ 0.923 \pm 0.003	³ 0.929 \pm 0.003	³ 0.930 \pm 0.003
B	⁴ 0.931 \pm 0.003	⁴ 0.936 \pm 0.003	⁴ 0.937 \pm 0.003
C	¹ 0.914 \pm 0.003	¹ 0.919 \pm 0.003	¹ 0.921 \pm 0.003
D	⁷ 0.981 \pm 0.002	⁷ 0.984 \pm 0.001	⁷ 0.985 \pm 0.001
E	² 0.922 \pm 0.003	² 0.928 \pm 0.003	² 0.928 \pm 0.003
F	⁵ 0.944 \pm 0.003	⁵ 0.950 \pm 0.003	⁵ 0.951 \pm 0.003
G	⁶ 0.976 \pm 0.002	⁶ 0.978 \pm 0.002	⁶ 0.978 \pm 0.002
H	⁸ 1.000 \pm 0.00007	⁸ 1.000 \pm 0.00007	⁸ 1.000 \pm 0.00007

Table 5. Values for FNIR at a FPIR of 10^{-1} when searching 10 000 latent distal phalanx images from SD 302 against enrollment sets with different numbers of enrolled subjects. Each column represents a different number of enrolled subjects in the enrollment set. The Baseline Data is recorded in blue. The best non-baseline value is reported in green and the worst in red. Challenger values that meet or beat the baseline are shaded in blue. Superscript numbers preceding the FNIR value represent its ranking in each column. The confidence intervals depicted are a 90% Wilson confidence interval [4].

Challenger	Enrolled Subjects					
	100 000		1 500 000		3 000 000	
	R = 1	R = 10	R = 1	R = 10	R = 1	R = 10
Ω	8.8	9.3	8.1	8.7	7.9	8.6
A	² 8.3	² 9.0	³ 7.5	² 8.1	³ 7.3	² 8.0
B	⁴ 7.4	⁴ 8.2	⁴ 6.8	⁴ 7.5	⁴ 6.6	⁴ 7.3
C	¹ 9.0	¹ 9.7	¹ 8.3	¹ 8.9	¹ 8.2	¹ 8.7
D	⁷ 2.1	⁷ 2.5	⁷ 1.8	⁷ 2.1	⁷ 1.7	⁷ 2.0
E	³ 8.2	³ 8.7	² 7.5	³ 8.1	² 7.4	³ 8.0
F	⁵ 5.8	⁵ 6.2	⁵ 5.2	⁵ 5.6	⁵ 5.1	⁵ 5.6
G	⁶ 2.5	⁶ 2.6	⁶ 2.3	⁶ 2.5	⁶ 2.2	⁶ 2.4
H	⁸ 0.0	⁸ 0.0	⁸ 0.0	⁸ 0.0	⁸ 0.0	⁸ 0.0

Table 6. Hit rate percentages for Ranks 1 ($R = 1$) and 10 ($R = 10$) when searching 10 000 latent distal phalanx images from SD 302 against enrollment sets with different numbers of enrolled subjects. Each column group represents a different number of enrolled subjects in the enrollment set. The Baseline Data is recorded in blue. The best non-baseline value is reported in green and the worst in red. Challenger values that meet or beat the baseline are shaded in blue. Superscript numbers preceding the hit rate value represent its ranking in each column.

5. Special Database 302

A subset of the data collected during the Nail to Nail Fingerprint Challenge was made available for free to researchers as a dataset called *SD 302*. This collection consists of all baseline and Challenger N2N data for 200 of the 331 subjects, as well as 50 distal phalanx latents for each of the 200 subjects.

5.1 Latent Identification

Search results for latent distal phalanx images included in SD 302 were extracted from the overall results reported in Section 3 for each enrollment set size and the analysis was repeated. Each search set contained 10 000 latent images.

FNIR values recorded at the Nail to Nail Fingerprint Challenge's fixed FPIR figure of merit are shown in Table 5. CMC values showing hit rate at Ranks 1 and 10 are shown in Table 6.

Challenger	FNIR @ FPIR = 10 ⁻¹ — Enrolled Subjects			
	30 000	300 000	1 500 000	3 000 000
Ω	0.056 ± 0.006	0.073 ± 0.007	0.079 ± 0.007	0.080 ± 0.007
A	³ 0.164 ± 0.01	³ 0.192 ± 0.01	³ 0.201 ± 0.01	³ 0.204 ± 0.01
B	⁵ 0.222 ± 0.01	⁵ 0.257 ± 0.01	⁵ 0.269 ± 0.01	⁵ 0.272 ± 0.01
C	¹ 0.068 ± 0.007	¹ 0.087 ± 0.007	¹ 0.094 ± 0.008	¹ 0.093 ± 0.008
D	⁷ 0.704 ± 0.01	⁷ 0.798 ± 0.01	⁷ 0.822 ± 0.01	⁷ 0.825 ± 0.01
E	² 0.152 ± 0.009	² 0.176 ± 0.01	² 0.187 ± 0.01	² 0.189 ± 0.01
F	⁴ 0.175 ± 0.01	⁴ 0.210 ± 0.01	⁴ 0.219 ± 0.01	⁴ 0.222 ± 0.01
G	⁶ 0.702 ± 0.01	⁶ 0.711 ± 0.01	⁶ 0.714 ± 0.01	⁶ 0.714 ± 0.01
H	⁸ 1.000 ± 0.0003	⁸ 1.000 ± 0.0003	⁸ 1.000 ± 0.0003	⁸ 1.000 ± 0.0003

Table 7. Values for FNIR at a FPIR of 10⁻¹ when searching ≤2 000 Challenger N2N images from SD 302 against enrollment sets with different numbers of enrolled subjects. Each column represents a different number of enrolled subjects in the enrollment set. The Baseline Data is recorded in blue. The best non-baseline value is reported in green and the worst in red. Challenger values that meet or beat the baseline are shaded in blue. Superscript numbers preceding the FNIR value represent its ranking in each column. The confidence intervals depicted are a 90% Wilson confidence interval [4].

Challenger	Hit Rate (Rank 1) — Enrolled Subjects			
	30 000	300 000	1 500 000	3 000 000
Ω	94.3	92.7	92.1	92.0
A	³ 83.5	³ 80.8	³ 79.9	³ 79.7
B	⁵ 77.8	⁵ 74.3	⁵ 73.1	⁵ 72.8
C	¹ 93.3	¹ 91.3	¹ 90.7	¹ 90.7
D	⁶ 30.1	⁷ 20.4	⁷ 17.8	⁷ 17.5
E	² 84.8	² 82.5	² 81.5	² 81.2
F	⁴ 82.7	⁴ 79.2	⁴ 78.2	⁴ 77.8
G	⁷ 29.8	⁶ 28.9	⁶ 28.6	⁶ 28.6
H	⁸ 0.0	⁸ 0.0	⁸ 0.0	⁸ 0.0

Table 8. Hit rate percentages for Rank 1 when searching ≤2 000 Challenger N2N images from SD 302 against enrollment sets with different numbers of enrolled subjects. Each column represents a different number of enrolled subjects in the enrollment set. The Baseline Data is recorded in blue. The best non-baseline value is reported in green and the worst in red. Challenger values that meet or beat the baseline are shaded in blue. Superscript numbers preceding the hit rate value represent its ranking in each column.

5.2 Nail to Nail Identification

Search results for N2N images included in SD 302 were extracted from the overall results reported in Section 4 for each enrollment set size and the analysis repeated. Each search set could have contained up to 2 000 individual fingerprints, depending on the failure to acquire rates reported in NISTIR 8210.

FNIR values recorded at the Nail to Nail Fingerprint Challenge’s fixed FPIR figure of merit are shown in Table 7. CMC values showing hit rate percentage at Rank 1 are shown in Table 8. Each row contains results for each of the enrollment set size variations tested.

This publication is available free of charge from: <https://doi.org/10.6028/NIST.IR.8257>

This publication is available free of charge from: <https://doi.org/10.6028/NIST.IR.8257>

References

- [1] Fiumara G, et al. (2018) Nail to Nail Fingerprint Challenge: Prize Analysis. *National Institute of Standards and Technology Interagency Report (NISTIR) 8210* <https://doi.org/10.6028/NIST.IR.8210>
- [2] Indovina M, Dvornychenko V, Hicklin RA, Kiebusinski GI (2012) Evaluation of Latent Fingerprint Technologies: Extended Feature Sets [Evaluation #2]. *NIST Interagency Report 7859* <https://doi.org/10.6028/NIST.IR.7859>
- [3] Chapman W, et al. (2013) Extended Feature Set Profile Specification. *National Institute of Standards and Technology Interagency Report (NISTIR) 1134* <https://doi.org/10.6028/NIST.IR.1134>
- [4] Wilson EB (1927) Probable Inference, the Law of Succession, and Statistical Inference. *Journal of the American Statistical Association* 22(158):209–212. <https://doi.org/10.2307/2276774>