



FR PIRAMID:

**Face Recognition Performance Investigation, Ranking
Assessment in Multiple Important Dimensions**

With Excerpts and Data Provided by

**National Institute of Standards and Technology
Ongoing Face Recognition Vendor Test (FRVT)**

Part 1: Verification

May 6, 2022

Abstract

CyberExtruder submitted its sixth-generation matching algorithm on March 16, 2022 to NIST for evaluation in the FRVT Ongoing Verification (1:1). NIST's stated goals for the FRVT tests are "To state absolute accuracy for different kinds of images, including those with and without subject cooperation. To state comparative accuracy, across algorithms." Of the hundreds of submissions NIST has evaluated, the accuracy metric for most vendor's algorithms has generally reached the 'Good Enough' plateau and is no longer the differentiator it once was. When accuracy is the only metric considered, total system performance is difficult to understand. This can lead to wasted time, effort, money and ultimately the purchase of systems that do not perform as expected in an actual deployment. Fortunately, FRVT reporting provides test data beyond just accuracy allowing the evaluation of the submissions in a more holistic multi-dimensional manner by combining accuracy with the resources an algorithm requires to perform its matching operations – template size, time to generate a template, and time to compare templates. A multi-dimensional understanding of face recognition systems is critical to assessing an algorithm's suitability in various use cases. In this white paper the authors offer both the rationale and the tools to compare algorithms using the accuracy and resources reported by the FRVT 1:1 NIST tests.

The complete NIST publication containing the data which forms the basis for this white paper is available free of charge from:

<https://www.nist.gov/programs-projects/face-recognition-vendor-test-frvt-ongoing>

WHAT NIST TESTS, AND WHY

The National Institute of Standards and Technology (NIST) administers the Face Recognition Vendors Test (FRVT) on an ongoing basis. The most recent evaluation tested 416 algorithms submitted by 19 academic institutions and 247 commercial developers from 35 different countries. The FRVT measures the performance of automated face recognition technologies which can be applied to a wide range of civil, law enforcement and homeland security applications. The FRVT performance reports include measurements of accuracy and resource consumption.

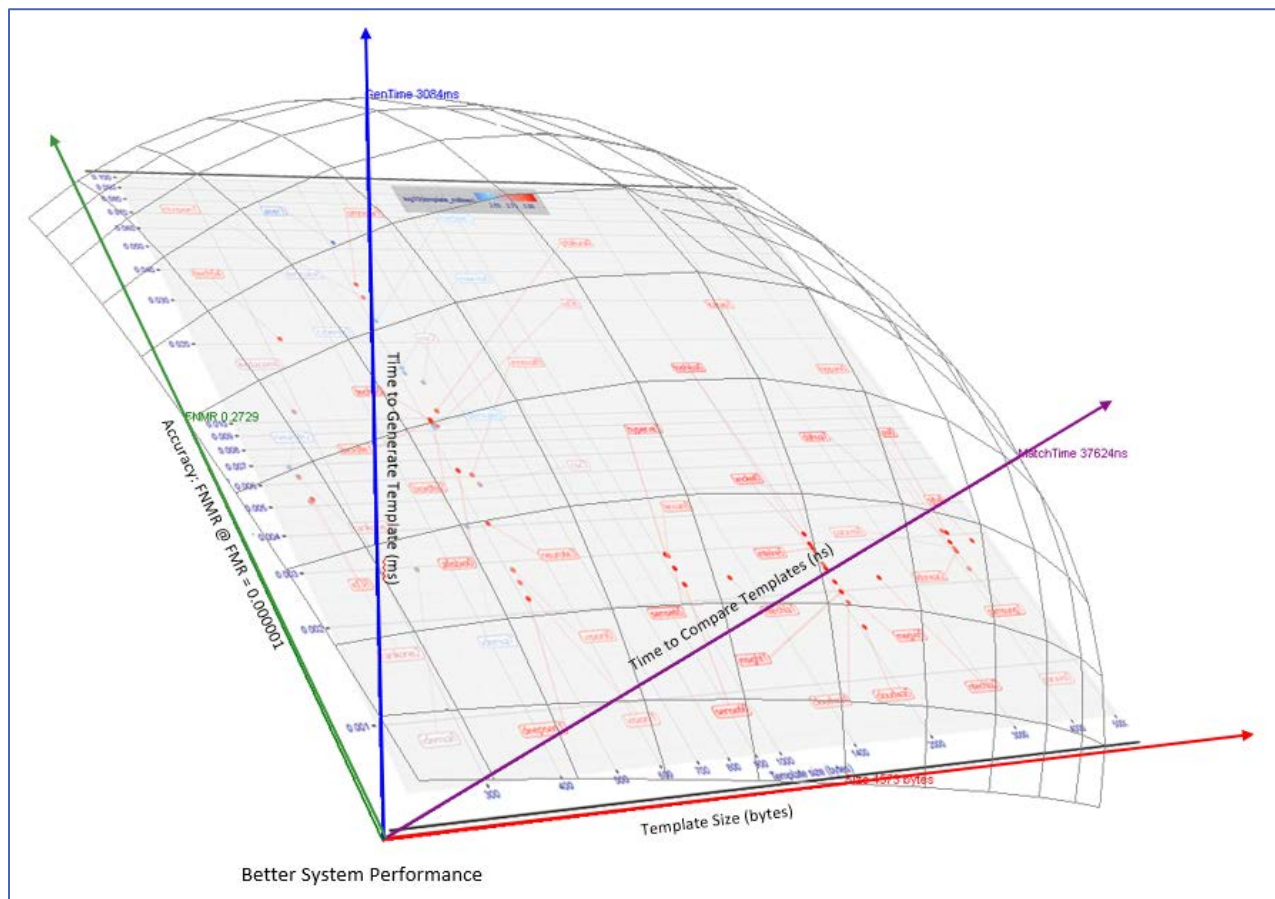
There are seven different datasets used by NIST; five of the sets are constrained and cooperative images and two sets of unconstrained, non-cooperative images (Wild images). The constrained images are divided into Visa images, Mugshot images and Border images while the unconstrained images are labelled as Wild and Kiosk images.

NIST also records the resources consumed by the algorithms such as template size (measured in bytes); the amount of time it takes for the algorithm to generate a template (measured in milliseconds (ms)); the amount of time it takes for the algorithm to compare two templates (measured in nanoseconds (ns)).

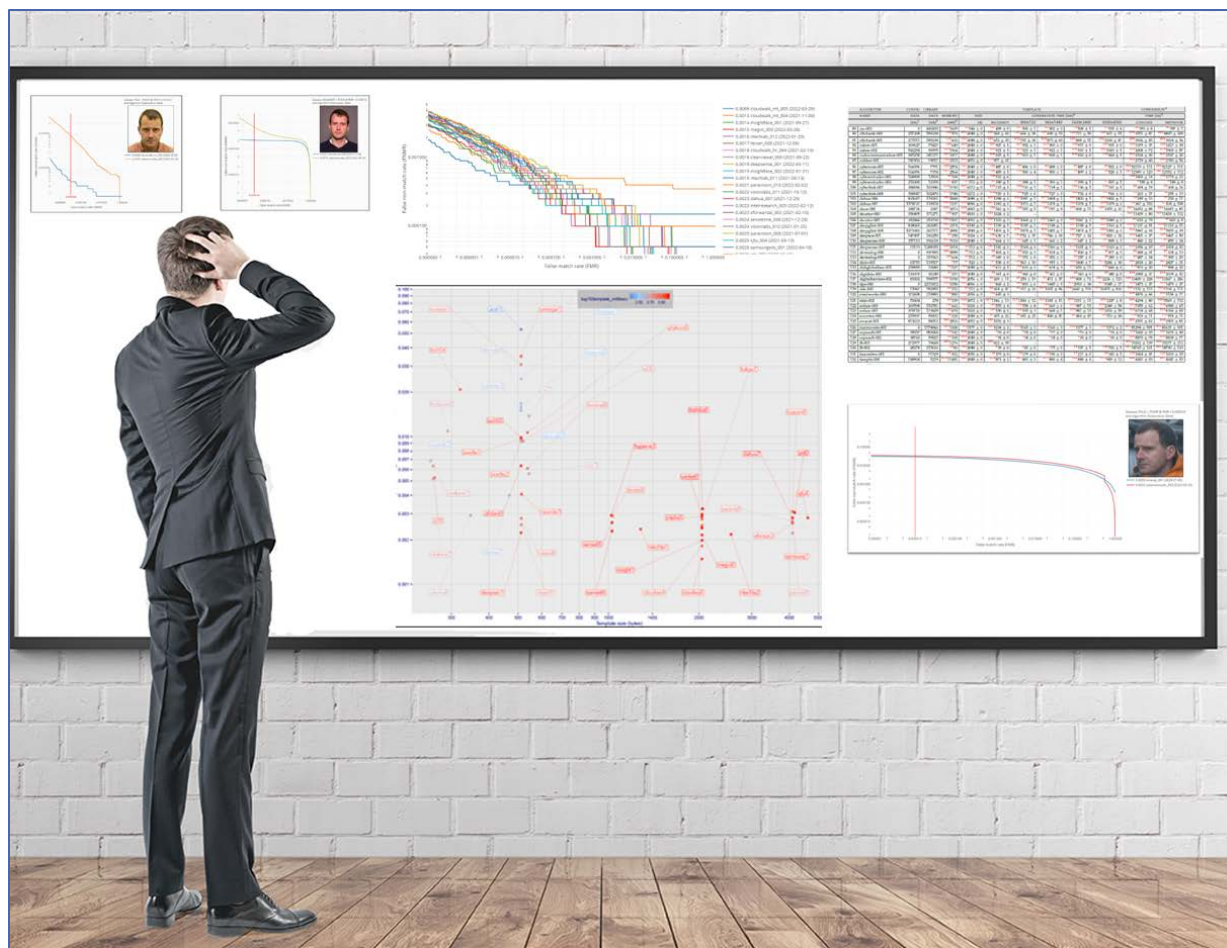


SO, WHAT'S THE POINT?

No single variable – especially accuracy – should be looked at by itself when evaluating a system's operational suitability. For example, if an algorithm gets very high accuracy rates but takes 3 seconds to create a template or the template size is 4kb or it takes 0.5 seconds to compare templates, it would not be an operationally deployable solution for surveillance usage. Therefore, it is the goal of this white paper to help readers look beyond the brass ring of a single dimension (accuracy) and provide them with the tools to evaluate face matching algorithms in 4 dimensions.

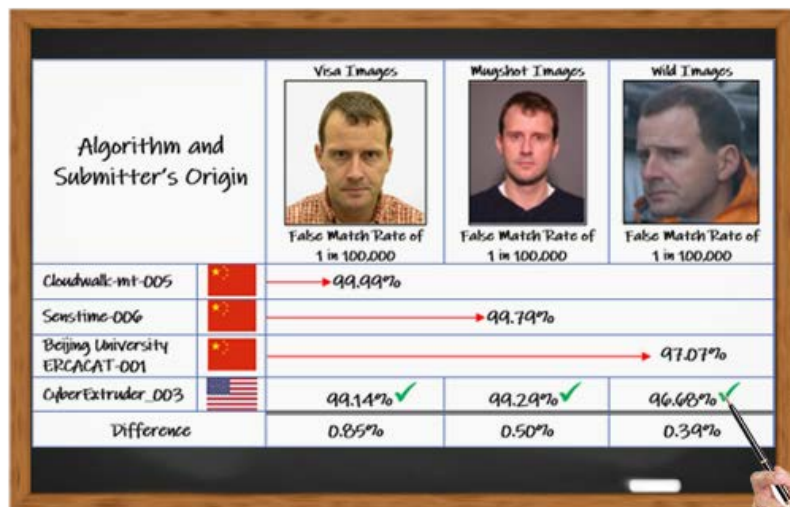


BUT IT'S ALL SO CONFUSING!



Readers of NIST publications are seeking unbiased validation to make informed decisions regarding the deployment and usage of a vendor's face recognition system. The FRVT reports provide all the data needed to understand the relationship between accuracy and resources. To facilitate a better understanding of these interdependencies the FRVT Ongoing Report contains a graphic on page 47 which plots matching accuracy (vertical (Y) axis), the size of the template (horizontal (X) axis) and the time to generate a template (colored map) to present a visualization of the practicality of a face matching system represented in a log 10 scale.

AND WHAT ABOUT THAT LEADERBOARD?

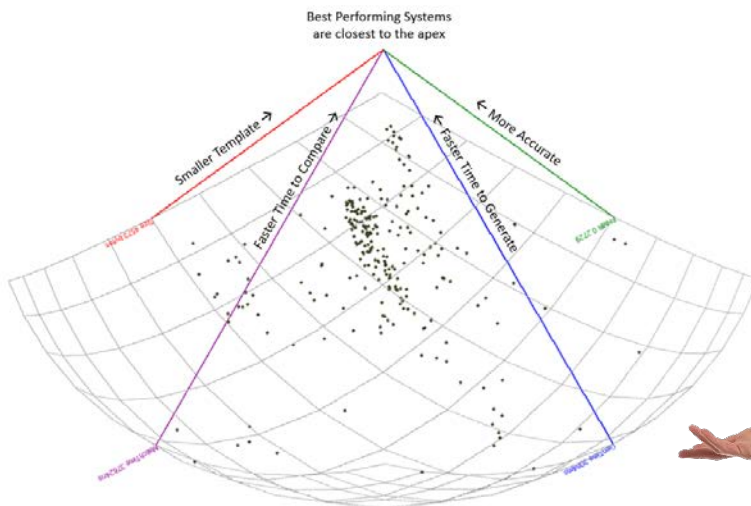


NIST's FRVT Ongoing Report is full of data on an algorithm's performance as applied to specific datasets and shown as a 'Leaderboard.' These plotted results provide a narrow view of an algorithm's capabilities easily leading to an incomplete understanding.

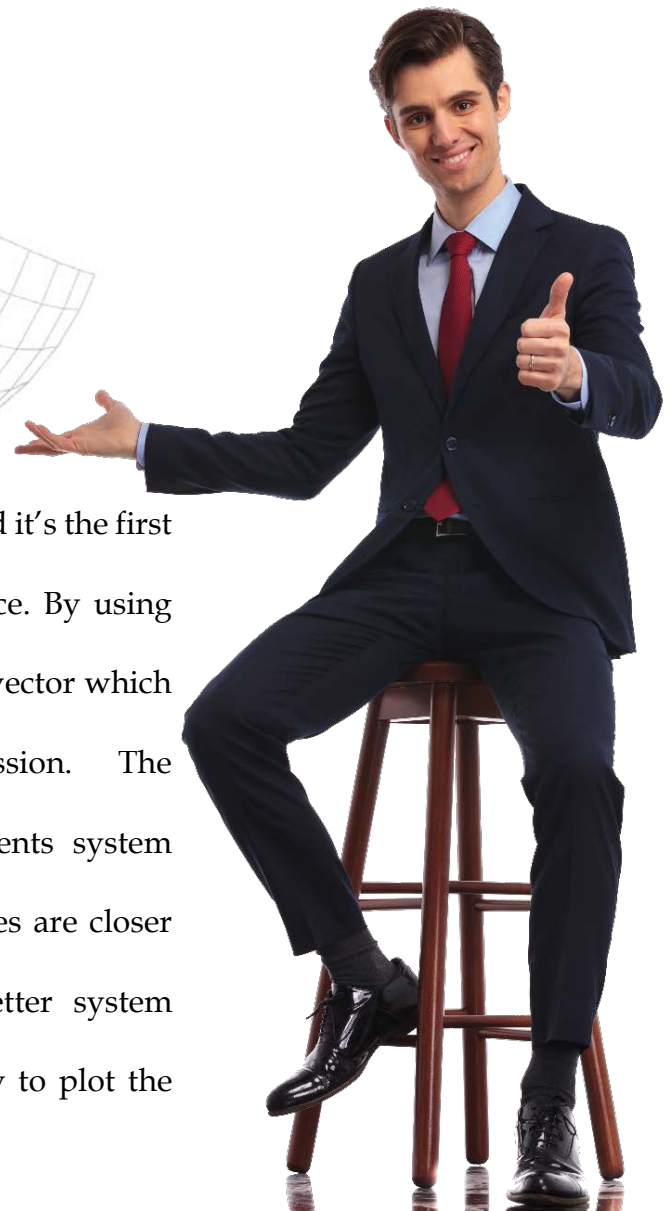
To fully understand the FRVT Ongoing Report the reader must look past singular statistics for individual evaluations of accuracy. Attaining high marks for matching accuracy on discrete tests is an impressive achievement, but its only part of the story because accuracy among recent submissions has increased to the point where one is practically indistinguishable from the next. Looking at these results, it's easy to see why the focus must shift from an accuracy leader board to overall system performance.

CHANGING THE CONVERSATION

To obtain an equivalent assessment of face recognition systems you must find a 'common language' because each variable has different units e.g., accuracy could be a percentage or proportion, template size is measured in bytes, template generation time is measured in milliseconds, and match time in nanoseconds. Arriving at this common language is called dimension *scaling*. Dimension scaling is the standard method of translating data from many variables in which each variable has different units

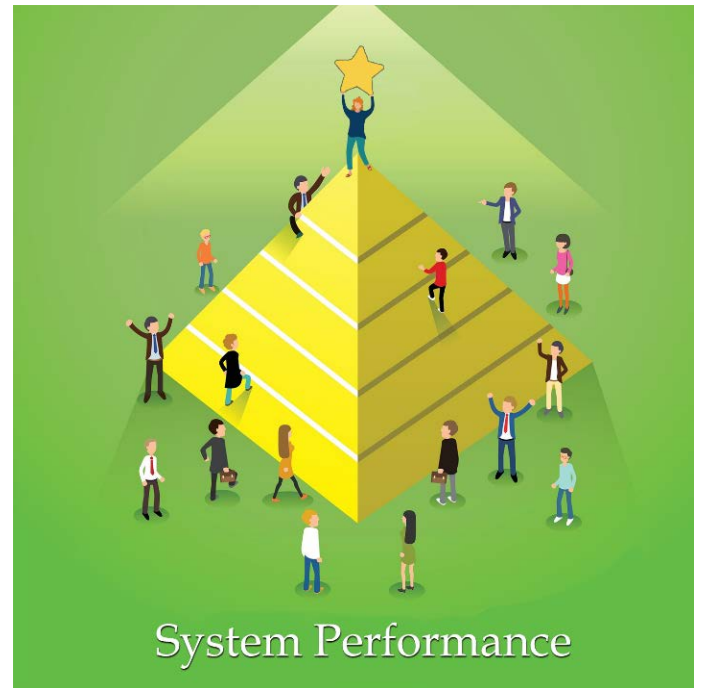


(accuracy, bytes, milliseconds, nanoseconds) and it's the first step in determining overall system performance. By using the *average* of each variable, we produce a 4D vector which provides a fair comparison of each submission. The magnitude (length) of this 4D vector represents system performance. When plotted, smaller magnitudes are closer the origin (pyramid apex) and represent better system performance. For more information about how to plot the variables in 4D See Appendix 1.



USING SYSTEM PERFORMANCE TO RANK FRVT DATA

You now have the understanding that FRVT accuracy data found in the leaderboard does not tell a complete story. You also understand that calculating system performance is not magical it's just math and we use it to describe 4 variables as a single value. Once we have that single value - the 4D vector we described earlier - we can easily see which algorithms are closer to the apex which tells us they perform better than others.



Let's look at the top ten algorithms in each dataset ranked by system performance.

NIST's Top 10 Submissions for the Visa image dataset Ranked by System Performance							
Rank	Algorithm	Location	Template Size (bytes)	Gen Time (milliseconds)	Match Time (nanoseconds)	Accuracy (FNMR)	System Performance (4D Magnitude)
1	dermalog-009	Germany	512	389	487	0.0094	0.32955
2	maxvision-000	China	512	370	2461	0.0106	0.34699
3	idemia-007	France	468	441	3243	0.0039	0.36467
4	idemia-008	France	348	513	3080	0.0032	0.37225
5	neurotechnology-012	Lithuania	256	583	119	0.007	0.37271
6	cyberextruder-003	United States	512	435	198	0.0169	0.38183
7	csc-003	United States	544	535	393	0.0065	0.39598
8	dermalog-008	Germany	512	477	468	0.0166	0.39847
9	csc-002	United States	544	514	367	0.0132	0.40611
10	kedacom-000	Singapore	292	665	684	0.0081	0.42667

The complete chart of Visa image rankings can be seen in Appendix 2.

USING SYSTEM PERFORMANCE TO RANK FRVT DATA

NIST's Top 10 Submissions for the Mugshot image dataset Ranked by System Performance							
Rank	Algorithm	Location	Template Size (bytes)	Gen Time (milliseconds)	Match Time (nanoseconds)	Accuracy (FNMR)	System Performance (4D Magnitude)
1	dermalog-009	Germany	512	389	487	0.0051	0.31802
2	cyberextruder-003	United States	512	435	198	0.0071	0.34261
3	hertasecurity-001	Spain	512	388	1770	0.0105	0.34432
4	maxvision-000	China	512	370	2461	0.011	0.3494
5	idemia-007	France	468	441	3243	0.0032	0.36391
6	dermalog-008	Germany	512	477	468	0.0086	0.36685
7	neurotechnology-012	Lithuania	256	583	119	0.0038	0.36711
8	idemia-008	France	348	513	3080	0.0023	0.37148
9	csc-002	United States	544	514	367	0.0077	0.38887
10	csc-003	United States	544	535	393	0.0037	0.39165

The complete chart of Mugshot image rankings can be seen in Appendix 3.

NIST's Top 10 Submissions for the Wild image dataset Ranked by System Performance							
Rank	Algorithm	Location	Template Size (bytes)	Gen Time (milliseconds)	Match Time (nanoseconds)	Accuracy (FNMR)	System Performance (4D Magnitude)
1	dermalog-009	Germany	512	389	487	0.03	0.37303
2	acer-001	Taiwan	512	259	2453	0.0391	0.38949
3	cyberextruder-003	United States	512	435	198	0.0332	0.40198
4	dermalog-008	Germany	512	477	468	0.0311	0.41182
5	idemia-007	France	468	441	3243	0.0309	0.41829
6	neurotechnology-012	Lithuania	256	583	119	0.0306	0.41944
7	idemia-008	France	348	513	3080	0.0304	0.42398
8	hertasecurity-000	Spain	256	139	710	0.0651	0.46202
9	hertasecurity-001	Spain	512	388	1770	0.0533	0.48475
10	maxvision-000	China	512	370	2461	0.0551	0.49609

The complete chart of Wild image rankings can be seen in Appendix 4.

LOOKING AHEAD

To illustrate the impact that a more efficient use of resources will have on system performance, we offer this comparison between our latest NIST submission (cyberextruder-003) and our commercially available product (cyberextruder-128). The improvements we made to the cyberextruder-003 algorithm reduced the template size, the time to generate the template and the time to compare templates while maintaining the same level of accuracy.

Algorithm	Template Size	Time to Generate	Time to Compare
cyberextruder-128	128 bytes	218 milliseconds	50 nanoseconds
cyberextruder-003	512 bytes	435 milliseconds	198 nanoseconds

When plotting the improved variables as described in this white paper, we are able to demonstrate the commercially available cyberextruder-128 algorithm significantly outperforms all other tested algorithms on all 3 datasets.

NIST Visa image dataset ranking by system performance compared to cyberextruder-128 algorithm

Rank	Algorithm	Location	Commercial	Template Size (bytes)	Gen Time (milliseconds)	Match Time (nanoseconds)	Accuracy (FNMR)	System Performance (4D Magnitude)
1	cyberextruder-128	United States	Commercial	128	218	50	0.0169	0.23396
2	dermalog-009	Germany	Commercial	512	389	487	0.0094	0.3303
3	maxvision-000	China	Commercial	512	370	2461	0.0106	0.34778
4	idemia-007	France	Commercial	468	441	3243	0.0039	0.36552
5	idemia-008	France	Commercial	348	513	3080	0.0032	0.37312

NIST Mugshot image dataset ranking by system performance compared to cyberextruder-128 algorithm

Rank	Algorithm	Location	Commercial	Template Size (bytes)	Gen Time (milliseconds)	Match Time (nanoseconds)	Accuracy (FNMR)	System Performance (4D Magnitude)
1	cyberextruder-128	United States	Commercial	128	218	50	0.0071	0.16192
2	dermalog-009	Germany	Commercial	512	389	487	0.0051	0.31875
3	cyberextruder-003	United States	Commercial	512	435	198	0.0071	0.3434
4	hertasecurity-001	Spain	Commercial	512	388	1770	0.0105	0.34511
5	maxvision-000	China	Commercial	512	370	2461	0.011	0.35021

NIST Wild image dataset ranking by system performance compared to cyberextruder-128 algorithm

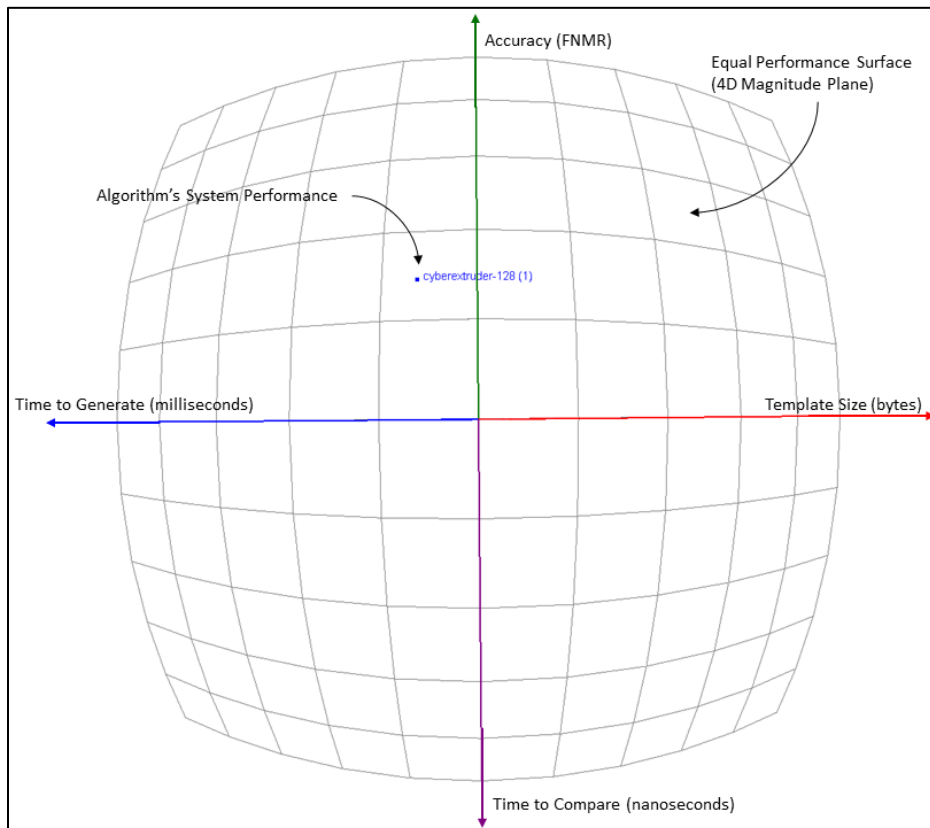
Rank	Algorithm	Location	Commercial	Template Size (bytes)	Gen Time (milliseconds)	Match Time (nanoseconds)	Accuracy (FNMR)	System Performance (4D Magnitude)
1	cyberextruder-128	United States	Commercial	128	218	50	0.0332	0.26567
2	dermalog-009	Germany	Commercial	512	389	487	0.03	0.37385
3	acer-001	Taiwan	Commercial	512	259	2453	0.0391	0.39032
4	cyberextruder-003	United States	Commercial	512	435	198	0.0332	0.40285
5	dermalog-008	Germany	Commercial	512	477	468	0.0311	0.41272

APPENDIX 1

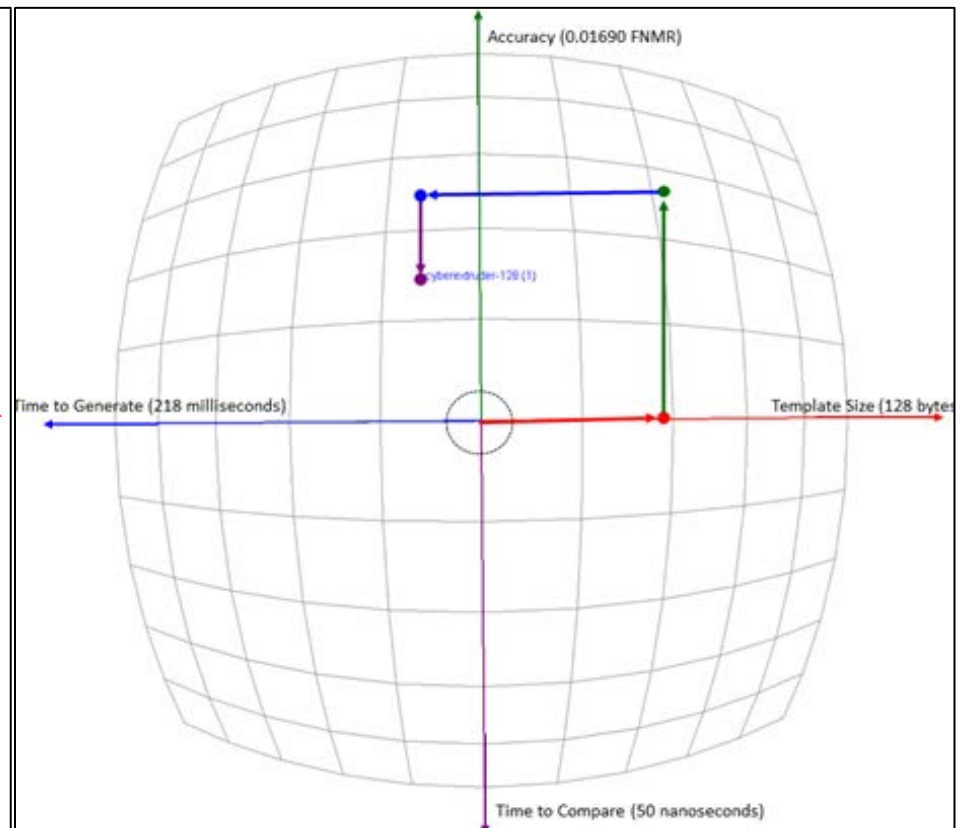
PLOTTING SYSTEM PERFORMANCE IN 4 DIMENSIONS

A 4-dimensional plot is designed to help the viewer understand multiple values (dimensions) relative to one another simultaneously. We plot each dimension of system performance along its corresponding axis and then project the magnitude of the system performance from the apex (origin). Starting at the apex we first plot template size followed by accuracy, then time to generate and finally time to compare.

Rank	Name	Location	Com...	Tsize	GenT...	MatchTi...	FNMR	3D Mag	4D Mag
1	cyberextruder-128	United States	✓	128	218	50	0.01690	0.23395	0.23396



Top-down view of a 4d plot. The apex (origin) is at the center of the plot.



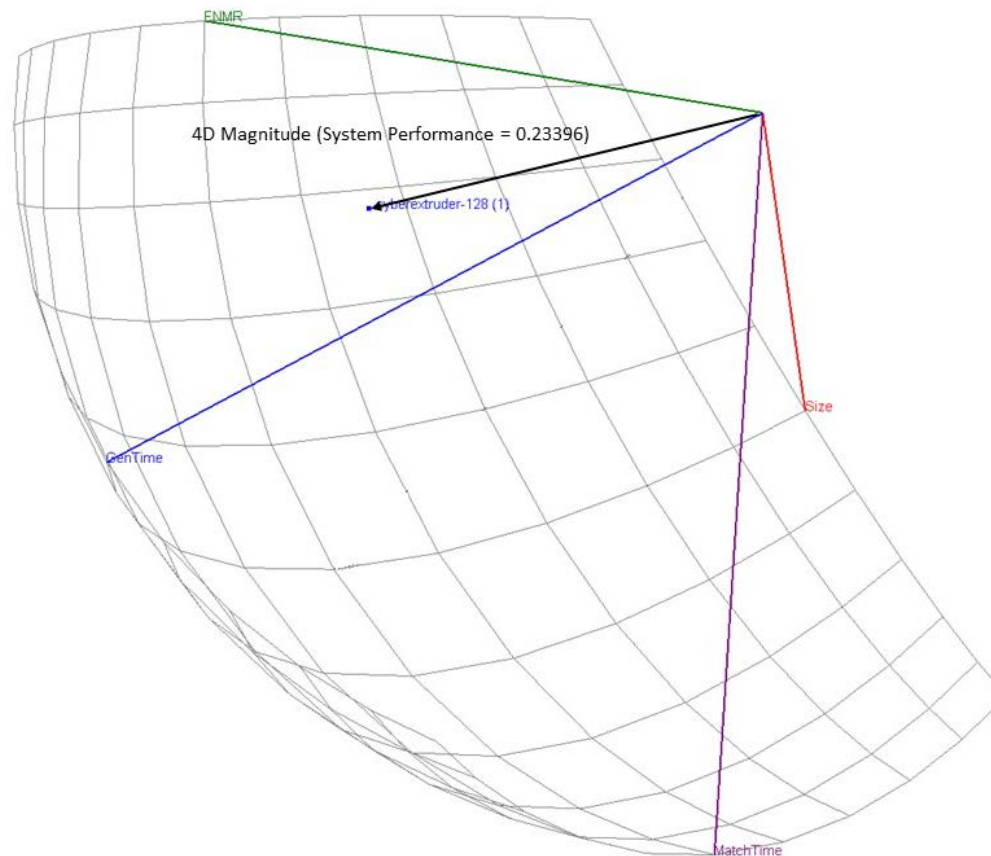
Perspective view of the 4D plot angled to show the system performance as measured in 4D magnitude.

APPENDIX 1

PLOTTING SYSTEM PERFORMANCE IN 4 DIMENSIONS

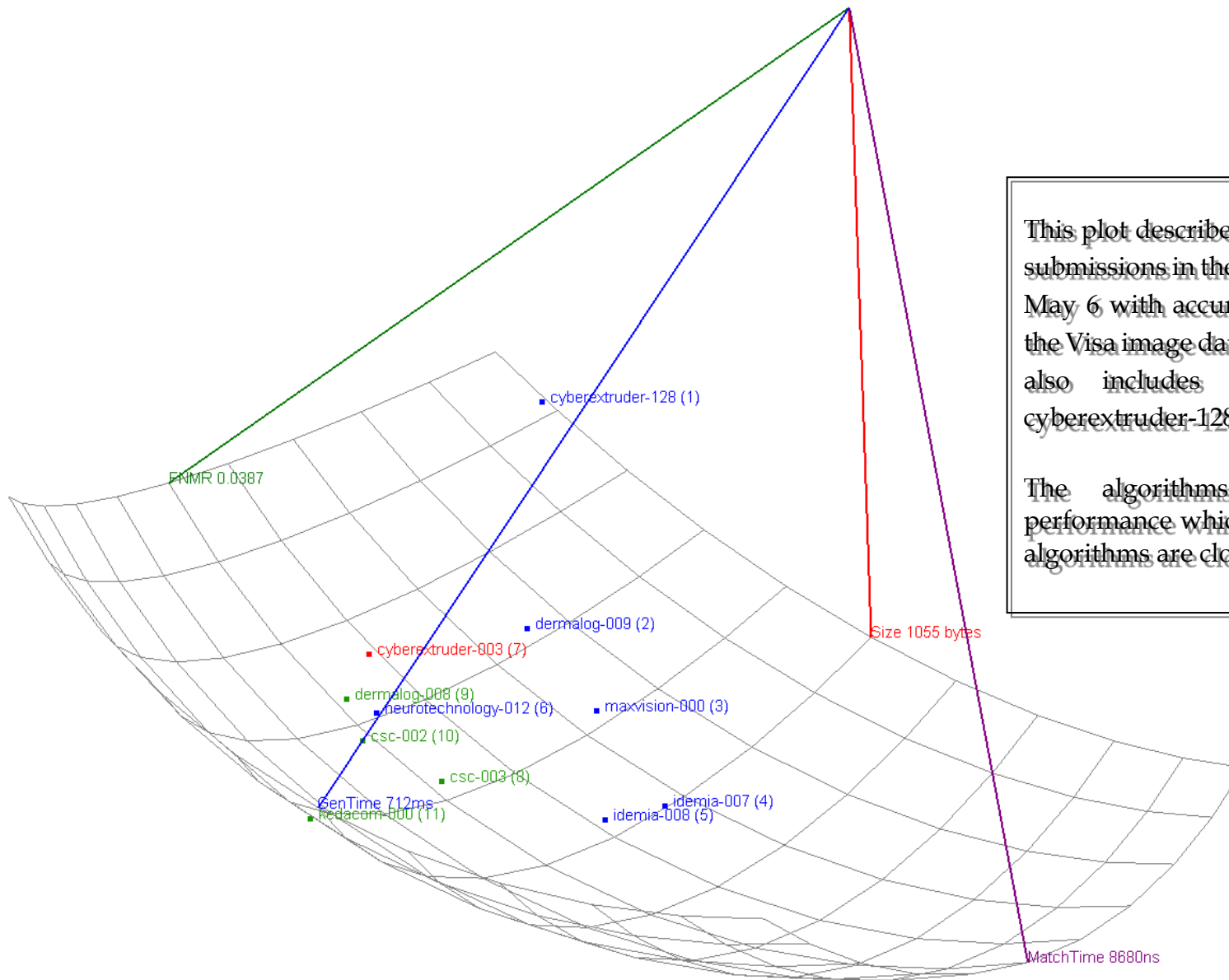
The last step is to project the 4D magnitude as the distance from the apex. Understanding this process will help you to visualize the relative system performance as reported by NIST.

Rank	Name	Location	Com...	Tsize	GenT...	MatchTi...	FNMR	3D Mag	4D Mag
1	cyberextruder-128	United States	✓	128	218	50	0.01690	0.23395	0.23396



APPENDIX 1

PLOTTING SYSTEM PERFORMANCE IN 4 DIMENSIONS

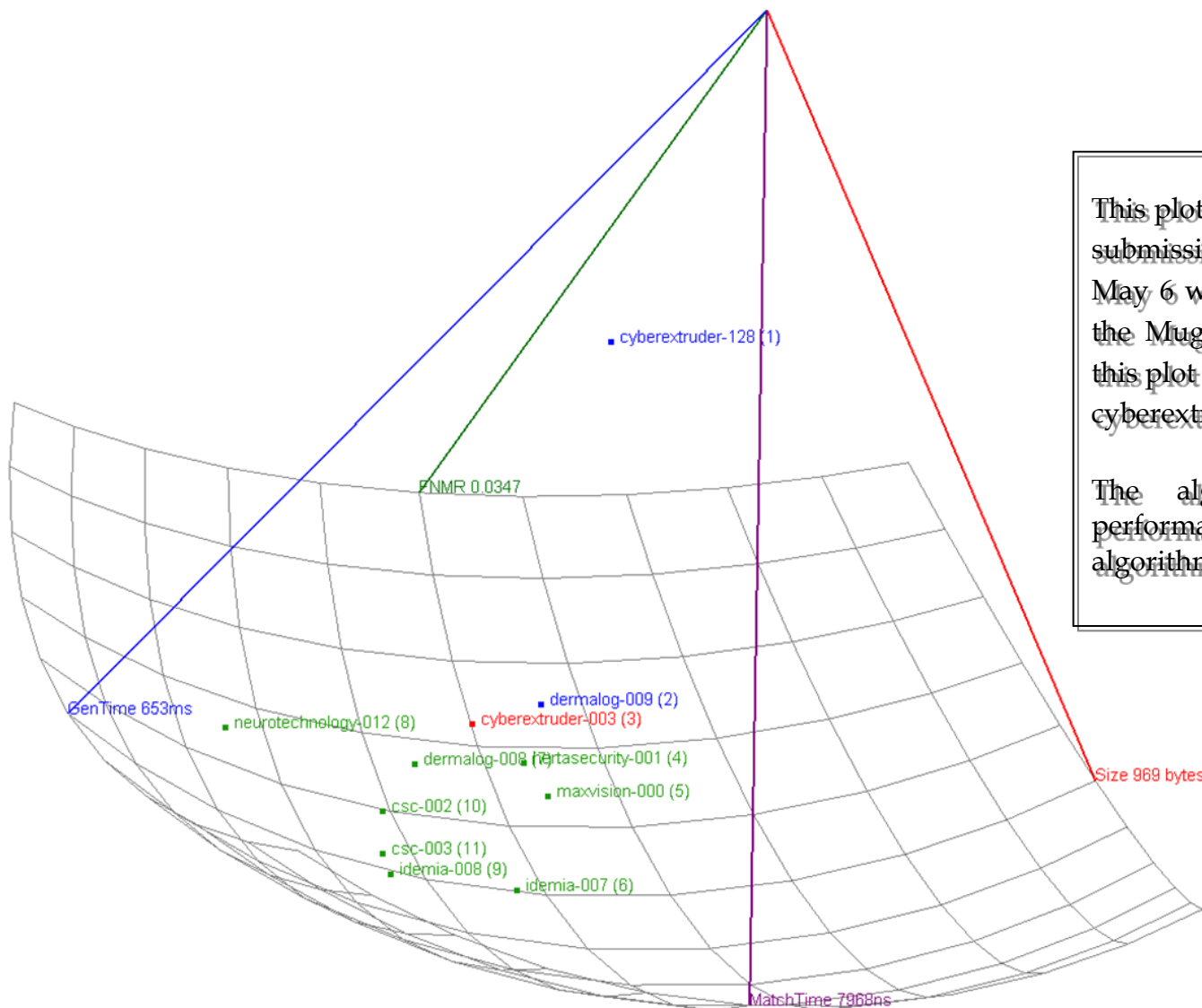


This plot describes the performance of the top 10 submissions in the NIST FRVT Ongoing Report of May 6 with accuracy and resources recorded in the Visa image dataset test. For reference, this plot also includes the commercially available cyberextruder-128 algorithm.

The algorithms are plotted by system performance which means the better performing algorithms are closer to the apex.

APPENDIX 1

PLOTTING SYSTEM PERFORMANCE IN 4 DIMENSIONS

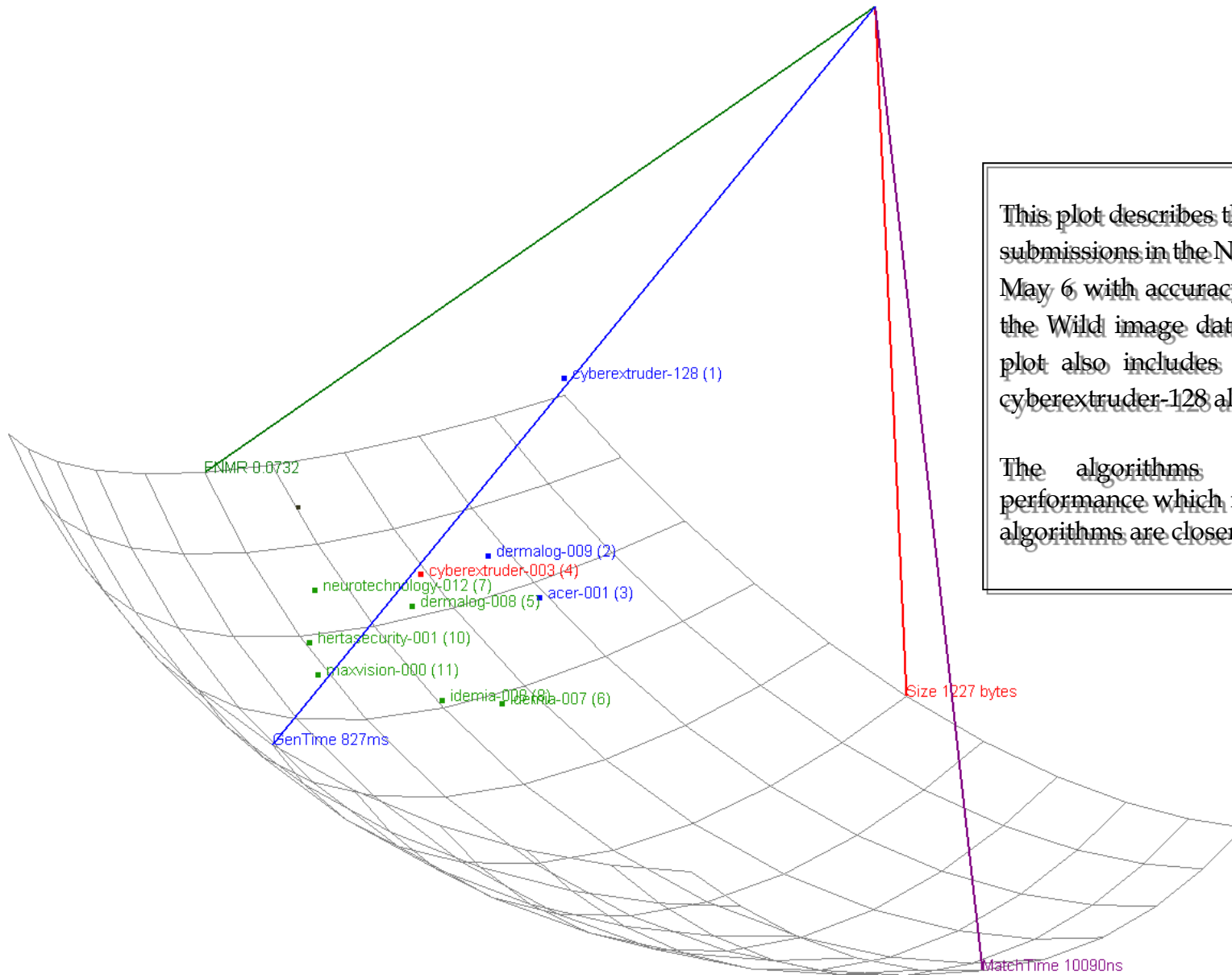


This plot describes the performance of the top 10 submissions in the NIST FRVT Ongoing Report of May 6 with accuracy and resources recorded in the Mugshot image dataset test. For reference, this plot also includes the commercially available cyberextruder-128 algorithm.

The algorithms are plotted by system performance which means the better performing algorithms are closer to the apex.

APPENDIX 1

PLOTTING SYSTEM PERFORMANCE IN 4 DIMENSIONS



This plot describes the performance of the top 10 submissions in the NIST FRVT Ongoing Report of May 6 with accuracy and resources recorded in the Wild image dataset test. For reference, this plot also includes the commercially available cyberextruder-128 algorithm.

The algorithms are plotted by system performance which means the better performing algorithms are closer to the apex.

APPENDIX 2

NIST PERFORMANCE ON THE VISA IMAGE DATASET

Rank	Algorithm	Location	Commercial Academic	Template Size	Gen Time	Match Time	Accuracy (FNMR)	Performance (4D Magnitude)
1	dermalog-009	Germany	Commercial	512	389	487	0.0094	0.32955
2	maxvision-000	China	Commercial	512	370	2461	0.0106	0.34699
3	idemia-007	France	Commercial	468	441	3243	0.0039	0.36467
4	idemia-008	France	Commercial	348	513	3080	0.0032	0.37225
5	neurotechnology-012	Lithuania	Commercial	256	583	119	0.007	0.37271
6	cyberextruder-003	United States	Commercial	512	435	198	0.0169	0.38183
7	csc-003	United States	Commercial	544	535	393	0.0065	0.39598
8	dermalog-008	Germany	Commercial	512	477	468	0.0166	0.39847
9	csc-002	United States	Commercial	544	514	367	0.0132	0.40611
10	kedacom-000	Singapore	Commercial	292	665	684	0.0081	0.42667
11	rankone-011	United States	Commercial	261	682	283	0.0075	0.43058
12	rankone-012	United States	Commercial	261	695	273	0.0058	0.43481
13	lookman-004	India	Commercial	548	656	871	0.0099	0.46646
14	hertasecurity-001	Spain	Commercial	512	388	1770	0.0309	0.47005
15	visionlabs-010	Russia	Commercial	513	739	600	0.0024	0.49084
16	visionlabs-011	Russia	Commercial	513	741	556	0.0022	0.49168
17	mvision-001	Russia	Commercial	512	710	1123	0.0233	0.54158
18	innovatrics-008	Slovakia	Commercial	538	853	3021	0.0064	0.5796
19	tevia-007	Russia	Commercial	1032	636	4894	0.0027	0.61505
20	acer-001	Taiwan	Commercial	512	259	2453	0.0504	0.62544
21	omnigarde-001	United States	Commercial	512	898	1405	0.026	0.64802
22	tech5-004	Switzerland	Commercial	321	999	597	0.0234	0.66576
23	bioidtechswiss-002	Switzerland	Commercial	512	1058	2177	0.0067	0.67984
24	deepsea-001	China	Commercial	1024	820	1401	0.0215	0.68866
25	vigilantsolutions-011	United States	Commercial	1548	445	339	0.0176	0.70782
26	afisbiometrics-000	United States	Commercial	512	1147	1400	0.0073	0.72598
27	anyvision-005	Israel	Commercial	1024	995	733	0.0037	0.72822
28	cogent-006	United States	Commercial	1062	971	1802	0.0059	0.73173
29	hik-001	China	Commercial	1408	737	488	0.0125	0.73417
30	ptakuratsatu-000	Indonesia	Commercial	538	1066	5900	0.0089	0.74134
31	tevia-008	Russia	Commercial	1032	946	4828	0.0017	0.74331
32	neurotechnology-013	Lithuania	Commercial	514	1195	109	0.0045	0.7477
33	vigilantsolutions-010	United States	Commercial	1548	659	490	0.0164	0.76241
34	hyperverge-002	India	Commercial	1024	975	6023	0.0066	0.77854
35	deepsense-001	China	Commercial	512	1323	2356	0.0019	0.82821
36	id3-006	France	Commercial	520	1270	5547	0.0103	0.84338
37	tech5-005	Switzerland	Commercial	512	1351	2573	0.0072	0.8493
38	cogent-007	United States	Commercial	550	1390	355	0.0038	0.86377
39	chtface-004	Taiwan	Commercial	2048	377	1727	0.0062	0.86529
40	revealmedia-006	United Kingdom	Commercial	2052	394	626	0.0067	0.8664
41	siat-005	China	Academic	2048	422	577	0.0038	0.86737
42	acisw-008	Thailand	Commercial	2048	336	1327	0.0147	0.87002
43	chtface-005	Taiwan	Commercial	2048	411	1907	0.0049	0.87074
44	hertasecurity-000	Spain	Commercial	256	139	710	0.078	0.8721

APPENDIX 2

NIST PERFORMANCE ON THE VISA IMAGE DATASET

Rank	Algorithm	Location	Commercial Academic	Template Size	Gen Time	Match Time	Accuracy (FNMR)	Performance (4D Magnitude)
45	intellivix-001	South Korea	Commercial	2048	421	1100	0.0087	0.87271
46	omnigarde-002	United States	Commercial	1024	1261	2727	0.0046	0.87385
47	multimodality-000	China	Commercial	2048	463	848	0.0047	0.87592
48	starhybrid-001	China	Commercial	2048	393	1075	0.0138	0.87595
49	sqisoft-002	South Korea	Commercial	2056	472	758	0.0124	0.88957
50	supremaid-001	South Korea	Commercial	2048	522	704	0.0073	0.88961
51	incode-009	United States	Commercial	2048	537	1102	0.0067	0.89321
52	sztu-001	China	Academic	2048	553	599	0.0043	0.89376
53	upc-001	China	Academic	1052	863	3114	0.0519	0.89469
54	rendip-000	Singapore	Commercial	2048	556	576	0.0077	0.89717
55	visionbox-002	Portugal	Commercial	2059	517	1969	0.0079	0.89789
56	viettelhightech-000	Viet Nam	Commercial	2048	494	599	0.0166	0.89885
57	acer-002	Taiwan	Commercial	2048	186	3370	0.0262	0.89961
58	cognitec-003	Germany	Commercial	2052	509	3417	0.0052	0.9017
59	clova-000	South Korea	Commercial	2048	508	1794	0.015	0.90207
60	sztu-000	China	Academic	2048	548	585	0.0139	0.90448
61	beethedata-000	Spain	Commercial	2048	467	2121	0.0195	0.9063
62	advance-003	Singapore	Commercial	2048	591	1813	0.0087	0.91021
63	facetag-002	South Korea	Commercial	2048	554	1730	0.0147	0.91085
64	imperial-002	Great Britain	Academic	2048	588	2278	0.0081	0.91136
65	id3-008	France	Commercial	264	1433	5658	0.0055	0.91139
66	ajou-001	South Korea	Academic	2048	577	597	0.0147	0.91249
67	pangiam-000	United States	Commercial	2048	639	118	0.0043	0.91369
68	kiwitech-000	China	Commercial	2048	609	1755	0.0105	0.91649
69	winsense-002	China	Commercial	2048	634	1683	0.0073	0.91847
70	mantra-000	India	Commercial	2052	598	3151	0.0052	0.91884
71	quantasoft-003	Czech Republic	Commercial	2048	634	201	0.0113	0.91974
72	intsysmsu-002	Russia	Academic	1024	1293	549	0.0254	0.92295
73	kuke3d-002	China	Commercial	2048	585	2943	0.0135	0.92299
74	vd-002	Finland	Commercial	516	754	300	0.0704	0.92321
75	cognitec-004	Germany	Commercial	2052	631	3028	0.0053	0.92582
76	didiglobalface-001	China	Commercial	2048	666	973	0.0092	0.92618
77	rokid-000	China	Commercial	2056	563	3457	0.0145	0.92713
78	ntechlab-011	Russia	Commercial	1280	1290	179	0.0019	0.93092
79	x-laboratory-000	China	Commercial	2056	673	725	0.0106	0.93215
80	iit-003	Russia	Academic	2048	661	324	0.0151	0.9332
81	3divi-007	United States	Commercial	2048	727	707	0.0038	0.9374
82	ionetworks-000	Taiwan	Commercial	2048	444	6913	0.0087	0.93877
83	imperial-000	Great Britain	Academic	2048	689	2130	0.0108	0.93893
84	scanovate-003	Israel	Commercial	2048	684	2926	0.008	0.93937
85	imagus-004	Australia	Commercial	2048	717	760	0.0094	0.93954
86	facesoft-000	Great Britain	Commercial	2048	687	2239	0.0112	0.93959
87	qnap-001	Taiwan	Commercial	2048	634	649	0.0215	0.94214
88	faceonlive-001	Germany	Commercial	2056	343	1064	0.0359	0.94513

APPENDIX 2

NIST PERFORMANCE ON THE VISA IMAGE DATASET

Rank	Algorithm	Location	Commercial Academic	Template Size	Gen Time	Match Time	Accuracy (FNMR)	Performance (4D Magnitude)
89	armatura-001	United States	Commercial	2048	756	270	0.0042	0.94527
90	advance-002	Singapore	Commercial	2048	718	987	0.0137	0.94674
91	intellcloudai-001	China	Commercial	2048	632	1056	0.0234	0.94804
92	3divi-006	United States	Commercial	2048	759	775	0.0094	0.95135
93	papsav1923-001	Turkey	Commercial	2048	744	725	0.013	0.95216
94	videmo-001	Germany	Commercial	2048	165	296	0.0417	0.95275
95	line-000	Japan	Commercial	2048	618	2753	0.0236	0.95355
96	realnetworks-006	United States	Commercial	2056	774	469	0.0056	0.95438
97	winsense-001	China	Commercial	1280	1320	1631	0.0099	0.95531
98	videmo-000	Germany	Commercial	2048	155	513	0.0423	0.95559
99	iit-002	Russia	Academic	2048	733	1023	0.0177	0.95897
100	aifirst-001	Thailand	Commercial	2048	755	1099	0.017	0.96375
101	intellifusion-001	China	Commercial	2048	805	1112	0.0094	0.96564
102	x-laboratory-001	China	Commercial	2056	793	813	0.011	0.96619
103	mukh-001	United States	Commercial	1024	1360	433	0.0285	0.96738
104	vd-003	Finalnd	Commercial	2052	722	1003	0.0222	0.96868
105	alphaface-002	China	Commercial	2048	828	945	0.0075	0.97017
106	anke-005	China	Commercial	2056	821	685	0.0109	0.97419
107	nazhiai-000	China	Commercial	2048	834	2230	0.0059	0.97573
108	sertis-000	Thailand	Commercial	2048	763	1497	0.0208	0.97631
109	line-001	Japan	Commercial	2048	833	2696	0.004	0.97709
110	imagus-005	Australia	Commercial	2048	411	731	0.042	0.98123
111	s1-004	South Korea	Commercial	2048	828	3245	0.008	0.98257
112	expasoft-002	Russia	Commercial	2048	34	8870	0.0274	0.98374
113	saffe-002	Germany	Commercial	2048	813	717	0.0206	0.9881
114	qnap-002	Taiwan	Commercial	2048	832	293	0.0191	0.98959
115	expasoft-001	Russia	Commercial	2048	74	1660	0.0488	0.99232
116	twface-000	Taiwan	Commercial	2048	898	1504	0.0072	0.99369
117	geo-002	Taiwan	Commercial	2048	803	3407	0.0187	0.99409
118	sensetime-005	China	Commercial	1028	1514	1223	0.0029	1.00072
119	netbridgetech-002	Taiwan	Commercial	2048	859	2893	0.0166	1.00241
120	deepsense-000	China	Commercial	2048	808	480	0.0265	1.0033
121	securifai-004	Romania	Commercial	2048	865	1711	0.0192	1.00337
122	cubox-001	South Korea	Commercial	2048	931	1379	0.008	1.00486
123	sensetime-006	China	Commercial	1028	1523	1179	0.0024	1.00533
124	twface-001	Taiwan	Commercial	2048	940	1400	0.0051	1.00564
125	authenmetric-004	China	Commercial	2048	950	1724	0.0042	1.00971
126	alchera-003	South Korea	Commercial	2048	918	3426	0.0055	1.01032
127	kakao-007	South Korea	Commercial	2048	968	1056	0.0028	1.01304
128	ceiec-003	China	Commercial	2048	944	2256	0.0107	1.01605
129	yoonik-003	Portugal	Commercial	2048	983	684	0.0047	1.01831
130	ctbcbank-000	Taiwan	Commercial	2048	831	3551	0.025	1.02012
131	rokid-001	China	Commercial	2060	901	3345	0.0162	1.02209
132	isap-002	Taiwan	Commercial	2048	912	3045	0.0186	1.02437
133	nodeflux-002	Indonesia	Commercial	2048	736	3475	0.034	1.02498

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Rank	Algorithm	Location	Commercial Academic	Template Size	Gen Time	Match Time	Accuracy (FNMR)	Performance (4D Magnitude)
134	facephi-000	Spain	Commercial	2048	949	4067	0.0059	1.0265
135	hyperverge-003	India	Commercial	1024	1565	566	0.003	1.02654
136	cubox-002	South Korea	Commercial	2048	1003	2008	0.0041	1.02917
137	vocord-010	Russia	Commercial	1088	1535	2724	0.0031	1.02941
138	maxvision-001	China	Commercial	2048	325	714	0.0528	1.0319
139	anke-004	China	Commercial	2056	982	633	0.0154	1.03328
140	androvideo-000	Taiwan	Commercial	2048	620	2860	0.0438	1.03806
141	authenmetric-003	China	Commercial	2048	1036	1757	0.0053	1.04042
142	vts-001	Viet Nam	Commercial	2048	709	9620	0.0048	1.04538
143	ceiec-004	China	Commercial	2048	1055	1844	0.0051	1.0475
144	alleyes-000	China	Commercial	2048	1057	1298	0.009	1.04945
145	t4isb-000	Brazil	Commercial	2048	1022	3586	0.0087	1.04954
146	fincore-000	United Kingdom	Commercial	2048	535	1765	0.0502	1.05042
147	knowutech-000	United States	Commercial	1536	1386	3743	0.0055	1.05539
148	alchera-002	South Korea	Commercial	2048	1025	3488	0.0157	1.05966
149	kakao-005	South Korea	Commercial	2052	1089	2067	0.0059	1.0627
150	kookmin-002	South Korea	Academic	2048	1116	638	0.0077	1.0685
151	pixelall-007	China	Commercial	2048	1124	708	0.0049	1.06961
152	yoonek-002	Portugal	Commercial	2048	1126	761	0.0062	1.07127
153	wuhantianyu-001	China	Commercial	2048	697	9502	0.0262	1.07805
154	ctbcbank-001	Taiwan	Commercial	2048	1030	3926	0.0235	1.08245
155	cybercore-002	Japan	Commercial	2048	528	12389	0.0119	1.08352
156	vinai-000	Viet Nam	Commercial	2048	1126	2996	0.0124	1.08718
157	fiberhome-nanjing-003	China	Commercial	2048	1154	1097	0.0139	1.09131
158	bresee-002	China	Commercial	2048	1176	1778	0.0101	1.09681
159	hzailu-001	China	Commercial	2056	1159	894	0.0164	1.09942
160	xforwardai-001	China	Commercial	2048	1203	779	0.0034	1.09949
161	via-001	Taiwan	Commercial	2048	1137	983	0.0229	1.10307
162	bioidtechswiss-001	Switzerland	Commercial	512	1793	2610	0.0072	1.10514
163	sertis-002	Thailand	Commercial	2048	1221	1086	0.0061	1.10864
164	incode-010	United States	Commercial	2048	1221	1164	0.0063	1.10897
165	via-000	Taiwan	Commercial	2048	1040	966	0.0365	1.11321
166	mobbl-003	Spain	Commercial	2048	691	12506	0.0134	1.12121
167	regula-001	United States	Commercial	2048	1255	361	0.0107	1.12527
168	innefulabs-000	India	Commercial	2048	1135	5782	0.0199	1.13044
169	seventhsense-000	Singapore	Commercial	2052	1272	1800	0.0099	1.13572
170	geo-004	Taiwan	Commercial	2048	1296	1023	0.0041	1.1376
171	seventhsense-001	Singapore	Commercial	2052	1288	1936	0.0047	1.13866
172	cloudwalk-hr-004	China	Commercial	2049	902	11652	0.0018	1.14336
173	lemalabs-001	India	Commercial	2048	844	11930	0.0175	1.15021
174	realnetworks-005	United States	Commercial	2056	1312	1213	0.0093	1.15066
175	tinkoff-001	Russia	Commercial	2048	1203	4361	0.0244	1.15088
176	cloudwalk-mt-004	China	Commercial	2048	927	11744	0.0013	1.15241
177	regula-000	United States	Commercial	2048	1159	491	0.0376	1.15827

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Rank	Algorithm	Location	Commercial Academic	Template Size	Gen Time	Match Time	Accuracy (FNMR)	Performance (4D Magnitude)
178	hisign-001	China	Commercial	2080	1325	201	0.005	1.15829
179	synology-002	Taiwan	Commercial	2048	1317	1466	0.0153	1.15888
180	scanovate-002	Israel	Commercial	2048	1172	3021	0.0355	1.16414
181	insightface-001	China	Commercial	2048	1386	1119	0.0014	1.17456
182	dahua-006	China	Commercial	2048	1402	249	0.0039	1.18084
183	insightface-002	China	Commercial	2048	1413	1169	0.0019	1.18627
184	clearviewai-000	United States	Commercial	2048	1418	1592	0.0019	1.1896
185	intelresearch-004	Iceland	Academic	2048	1411	4696	0.0035	1.20675
186	intelresearch-005	Iceland	Commercial	2048	1423	4524	0.0023	1.20987
187	toshiba-005	Japan	Commercial	2056	1459	1613	0.0037	1.21009
188	pixelall-006	China	Commercial	2560	1054	754	0.0042	1.21424
189	toshiba-004	Japan	Commercial	2056	1479	1020	0.0042	1.21743
190	ivacognitive-001	Russia	Commercial	2048	1321	4228	0.0351	1.22738
191	innovativetechnologyltd-002	Great Britain	Commercial	2048	766	1841	0.0716	1.23687
192	vnpt-004	Viet Nam	Commercial	2048	1505	4047	0.0078	1.24378
193	deepglint-004	China	Commercial	2048	1492	5961	0.0034	1.25429
194	pxl-001	Switzerland	Commercial	512	1470	5598	0.0752	1.25888
195	remarkai-001	China	Commercial	2052	1519	1229	0.0256	1.26548
196	cloudwalk-mt-005	China	Commercial	2048	1229	12525	0.0009	1.26799
197	papsav1923-002	Turkey	Commercial	2052	1641	1209	0.0034	1.28897
198	aiunionface-000	Taiwan	Commercial	2048	1639	1072	0.0154	1.29736
199	decaturn-001	United States	Commercial	2052	1084	610	0.0711	1.31454
200	daon-000	Ireland	Commercial	2065	1055	16052	0.0117	1.31774
201	aize-001	Japan	Commercial	2048	1583	1937	0.0344	1.31906
202	mobai-001	Norway	Commercial	2048	1707	1386	0.0219	1.34028
203	f8-002	Taiwan	Commercial	2048	702	14765	0.0591	1.34735
204	notiontag-002	India	Commercial	2120	471	20278	0.0089	1.34817
205	turingtechvip-001	China	Commercial	2048	1476	1733	0.054	1.35339
206	ntechlab-012	Russia	Commercial	2560	1460	211	0.0016	1.3558
207	innovativetechnologyltd-001	Great Britain	Commercial	2048	485	1877	0.0938	1.36067
208	kneron-005	United States	Commercial	2048	1760	1922	0.0259	1.37478
209	tiger-006	United States	Commercial	2052	1848	1810	0.0101	1.39158
210	aware-006	United States	Commercial	352	1754	2598	0.0819	1.40009
211	yuan-003	Taiwan	Commercial	2048	1878	2320	0.0111	1.40771
212	icthtc-000	China	Academic	2048	1719	5284	0.0396	1.41656
213	innovatrics-007	Slovakia	Commercial	1064	2210	5978	0.0054	1.42505
214	samsungsds-000	South Korea	Commercial	2048	343	23722	0.0069	1.44681
215	irex-000	United States	Commercial	3080	1249	201	0.0099	1.45734
216	vocord-009	Russia	Commercial	1920	2064	2052	0.0029	1.46471
217	mobipintech-000	South Korea	Commercial	2048	1707	14506	0.0149	1.5062
218	enface-000	Russia	Commercial	1024	2349	7059	0.0049	1.50942
219	kneron-003	United States	Commercial	2048	1224	5237	0.0902	1.51077
220	synesis-007	Russia	Commercial	3080	1423	684	0.0073	1.51214
221	enface-001	Russia	Commercial	1024	2416	6734	0.0107	1.54703
222	sktelecom-000	South Korea	Commercial	1536	1155	26583	0.0054	1.60497

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Rank	Algorithm	Location	Commercial Academic	Template Size	Gen Time	Match Time	Accuracy (FNMR)	Performance (4D Magnitude)
223	visage-000	Sweden	Commercial	512	63	2220	0.1441	1.6086
224	aware-005	United States	Commercial	1572	2195	1475	0.0643	1.62645
225	sjtu-003	China	Academic	2048	2373	1560	0.0033	1.64842
226	xm-000	China	Academic	2052	2434	1634	0.0026	1.68091
227	revealmedia-005	United Kingdom	Commercial	4100	442	2023	0.0074	1.68379
228	verihubs-inteligensia-000	Indonesia	Commercial	2048	1621	22351	0.0098	1.68786
229	suprema-001	South Korea	Commercial	2048	2443	3212	0.0053	1.69104
230	icm-003	Australia	Commercial	2048	1381	24351	0.0222	1.6923
231	paravision-010	United States	Commercial	4100	635	1577	0.0021	1.7029
232	corsight-002	Israel	Commercial	2080	1388	24953	0.0068	1.70579
233	synesis-006	Russia	Commercial	4104	639	697	0.0096	1.70673
234	paravision-008	United States	Commercial	4096	702	337	0.0025	1.70915
235	suprema-002	South Korea	Commercial	2048	2479	3255	0.0041	1.70957
236	kakaopay-001	South Korea	Commercial	4096	553	633	0.0252	1.71211
237	yuan-004	Taiwan	Commercial	4096	607	5816	0.0078	1.7218
238	camvi-002	United States	Commercial	1024	2785	612	0.0221	1.73787
239	intellcloudai-002	China	Commercial	4100	878	822	0.0085	1.74239
240	xforwardai-002	China	Commercial	4096	967	1406	0.0023	1.7563
241	kuke3d-001	China	Commercial	4096	834	6412	0.0104	1.76226
242	s1-003	South Korea	Commercial	4096	955	3657	0.0073	1.76342
243	closeli-001	China	Commercial	4096	865	5404	0.0163	1.76491
244	remarkai-003	China	Commercial	4100	1019	787	0.0063	1.76861
245	sodec-000	Turkey	Commercial	4096	1061	1794	0.0044	1.77703
246	minivision-000	China	Commercial	4096	1059	2466	0.0048	1.77867
247	fujitsulab-003	China	Commercial	4104	1045	2855	0.0065	1.78077
248	digidata-000	India	Commercial	2048	380	2084	0.141	1.78096
249	itmo-008	Russia	Academic	4096	1104	3578	0.015	1.79986
250	intellifusion-002	China	Commercial	4096	1171	1713	0.0077	1.80285
251	aimall-003	China	Commercial	1024	807	34565	0.0041	1.81487
252	allgovision-000	India	Commercial	2048	710	29903	0.0527	1.83457
253	verigram-001	Kazakhstan	Commercial	2048	2733	1664	0.0044	1.83846
254	fiberhome-nanjing-004	China	Commercial	4096	1326	1276	0.0056	1.83925
255	fujitsulab-002	China	Commercial	4104	1327	2836	0.0124	1.85066
256	dahua-007	China	Commercial	4096	1379	367	0.0023	1.85138
257	20face-001	Netherlands	Commercial	4096	267	5553	0.0732	1.86985
258	psl-010	Singapore	Commercial	4168	1396	354	0.0035	1.8822
259	uluface-002	China	Commercial	2048	2333	19207	0.0123	1.88469
260	verigram-000	Kazakhstan	Commercial	2048	2848	1222	0.0043	1.89934
261	vnpt-003	Viet Nam	Commercial	4096	1428	7397	0.0138	1.90564
262	psl-009	Singapore	Commercial	4168	1385	316	0.0294	1.90669
263	megvii-005	China	Commercial	2049	1298	32025	0.0015	1.94163
264	camvi-004	United States	Commercial	2048	2891	948	0.0316	1.95301
265	alice-000	Spain	Commercial	4096	1264	14975	0.0192	1.97586
266	shu-003	China	Academic	2048	3045	2506	0.0041	2.00903

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Rank	Algorithm	Location	Commercial Academic	Template Size	Gen Time	Match Time	Accuracy (FNMR)	Performance (4D Magnitude)
267	facex-002	India	Commercial	2048	1738	631	0.1404	2.04345
268	meituan-000	China	Commercial	2048	3126	638	0.0424	2.10209
269	ytu-000	China	Commercial	2048	1949	31797	0.0087	2.12201
270	toppanidgate-000	Taiwan	Commercial	4096	917	25262	0.0033	2.14202
271	bresee-001	China	Commercial	2048	1360	37240	0.0143	2.17388
272	adera-002	Singapore	Commercial	5120	1464	2163	0.0071	2.25253
273	adera-003	Singapore	Commercial	5120	1469	2148	0.0059	2.25324
274	intellivision-002	United States	Commercial	2056	600	13525	0.1775	2.25905
275	kasikornlabs-000	Thailand	Commercial	2048	2382	31669	0.0184	2.27805
276	meituan-001	China	Commercial	2048	1011	654	0.1886	2.32174
277	uluface-003	China	Commercial	3072	2469	26057	0.015	2.32422
278	nsensecorp-003	South Korea	Commercial	2048	659	44658	0.0295	2.40119
279	intellivision-003	United States	Commercial	2056	591	11069	0.2006	2.45322
280	sjtu-004	China	Academic	4608	2738	3057	0.0025	2.48796
281	cyberlink-008	Taiwan	Commercial	6212	760	263	0.0056	2.55358
282	cyberlink-007	Taiwan	Commercial	6212	767	304	0.0053	2.55426
283	gorilla-007	Taiwan	Commercial	6288	722	3686	0.0111	2.58837
284	sqisoft-001	South Korea	Commercial	2056	1393	797	0.2088	2.58942
285	canon-004	Japan	Commercial	6200	1064	7172	0.0091	2.61268
286	cloudmatrix-000	Taiwan	Commercial	2048	793	49192	0.034	2.62648
287	canon-003	Japan	Commercial	6180	1482	4783	0.0059	2.66333
288	ekin-002	Turkey	Commercial	3072	1207	4294	0.2042	2.68225
289	deepglint-003	China	Commercial	6144	1163	17227	0.0038	2.716
290	cloudmatrix-001	Taiwan	Commercial	2048	169	50263	0.1141	2.89587
291	tiger-005	United States	Commercial	2052	1088	620	0.245	2.90387
292	aize-002	Japan	Commercial	2048	4617	597	0.0327	2.91207
293	beyneai-000	Kazakhstan	Commercial	2048	4669	3730	0.0107	2.92747
294	megvii-004	China	Commercial	4097	1436	46801	0.0033	2.9628
295	awiros-002	India	Commercial	2048	946	1966	0.2561	3.00207
296	antheus-001	Brazil	Commercial	520	2660	6218	0.2306	3.02719
297	synology-000	Taiwan	Commercial	2048	4568	19720	0.0238	3.03242
298	visteam-003	Portugal	Academic	4096	1370	6816	0.2166	3.04127
299	nhn-003	South Korea	Commercial	4096	1375	50560	0.0048	3.09851
300	20face-000	Netherlands	Commercial	2048	224	44880	0.1828	3.10535
301	luxand-000	United States	Commercial	1040	562	828	0.2814	3.15364
302	samsungsds-001	South Korea	Commercial	4096	1514	51559	0.0026	3.16063
303	wicket-000	United States	Commercial	2048	1537	60976	0.0028	3.2431
304	mendaxiatech-000	China	Commercial	4097	2689	46906	0.0036	3.26501
305	vinbigdata-001	Viet Nam	Commercial	2048	1404	1351	0.2763	3.27192
306	oz-004	Russia	Commercial	2053	1608	61654	0.0049	3.28697
307	nhn-002	South Korea	Commercial	4096	1203	56608	0.0096	3.31897
308	openface-001	South Korea	Commercial	2048	616	608	0.2921	3.3503
309	aigen-002	Thailand	Commercial	2048	5427	3678	0.0343	3.38374
310	mobai-000	Norway	Commercial	6144	3549	16458	0.0439	3.40426
311	gorilla-008	Taiwan	Commercial	8338	720	4530	0.0091	3.40773

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Rank	Algorithm	Location	Commercial Academic	Template Size	Gen Time	Match Time	Accuracy (FNMR)	Performance (4D Magnitude)
312	pensees-001	Singapore	Commercial	8200	1546	3151	0.0133	3.44938
313	aigen-001	Thailand	Commercial	2048	5691	3772	0.0219	3.52443
314	boetech-002	China	Commercial	2048	348	68921	0.0565	3.5487
315	visteam-002	Portugal	Academic	4096	1013	6952	0.2789	3.56529
316	boetech-001	China	Commercial	2048	318	68519	0.0802	3.58436
317	visionbox-001	Portugal	Commercial	2048	5955	1161	0.027	3.67779
318	aimall-002	China	Commercial	2048	1003	72811	0.0167	3.72668
319	asusaics-000	Taiwan	Commercial	2048	6305	5455	0.0209	3.8861
320	ayftech-001	China	Commercial	512	5412	615	0.1941	3.89436
321	veridas-007	Spain	Commercial	2048	6374	655	0.0083	3.91159
322	griaule-000	United States	Commercial	2052	6406	3987	0.0099	3.93588
323	neosystems-003	Canada	Commercial	2048	2273	19130	0.3349	4.13522
324	antheus-000	Brazil	Commercial	520	236	6901	0.3776	4.1906
325	oz-003	Russia	Commercial	2053	3209	73905	0.0143	4.19648
326	omsecurity-000	South Korea	Commercial	1024	193	481	0.3835	4.25613
327	tuputech-000	China	Commercial	2048	411	23893	0.3696	4.33344
328	digitalbarriers-002	Great Britain	Commercial	2056	2236	13409	0.369	4.41836
329	asusaics-001	Taiwan	Commercial	4096	7284	8618	0.021	4.6957
330	veridas-006	Spain	Commercial	2048	6414	56940	0.0167	4.83126
331	neosystems-002	Canada	Commercial	2048	2247	18752	0.4077	4.8594
332	awiros-001	India	Commercial	512	556	1079	0.4622	5.11858
333	mobbl-001	Spain	Commercial	2048	2781	11832	0.4375	5.20943
334	graymatics-001	United States	Commercial	4096	7150	39874	0.162	5.30672
335	moreidian-000	China	Commercial	2048	713	1803	0.4912	5.50364
336	glory-003	Japan	Commercial	4234	8941	6020	0.0125	5.637
337	euronovate-001	Switzerland	Commercial	1177	1172	81294	0.3608	5.70566
338	dps-000	France	Commercial	4096	9345	1473	0.0176	5.84637
339	glory-004	Japan	Commercial	4182	9360	4982	0.0123	5.86794
340	ailabs-001	Taiwan	Commercial	2048	5205	104034	0.0276	6.05502
341	acisw-007	Thailand	Commercial	2048	484	1316	0.5493	6.12842
342	vts-000	Viet Nam	Commercial	2048	517	124209	0.0174	6.17154
343	unissey-001	France	Commercial	4096	10017	1463	0.016	6.23304
344	videonetics-002	India	Commercial	2052	3151	1219	0.5329	6.23547
345	techsign-000	Turkey	Commercial	2048	10460	4758	0.0511	6.35541
346	nsensecorp-002	South Korea	Commercial	2048	351	45965	0.5375	6.40733
347	farfaces-001	United Kingdom	Commercial	512	1209	855	0.586	6.51405
348	alfabeta-001	Indonesia	Commercial	512	2547	470	0.5831	6.62004
349	iws-000	United States	Commercial	512	2987	999	0.5801	6.65408
350	dsk-000	China	Commercial	512	10451	7152	0.2169	6.72061
351	cybercore-001	Japan	Commercial	2048	502	52119	0.5677	6.82842
352	chosun-001	South Korea	Academic	2048	11694	998	0.0936	7.13558
353	videonetics-001	India	Commercial	512	2393	1153	0.6446	7.26351
354	facetag-000	South Korea	Commercial	684	7930	72003	0.4081	7.45053
355	netbridgetech-001	Taiwan	Commercial	4096	113	9280	0.6599	7.48617

APPENDIX 2

NIST PERFORMANCE ON THE VISA IMAGE DATASET

Rank	Algorithm	Location	Commercial Academic	Template Size	Gen Time	Match Time	Accuracy (FNMR)	Performance (4D Magnitude)
356	eocortex-000	Russia	Commercial	2048	513	923	0.6943	7.71677
357	lebentech-000	Mexico	Commercial	512	23	801	0.7032	7.76704
358	dicio-001	Mexico	Commercial	520	5286	2818	0.6442	7.79098
359	biocube-001	India	Commercial	4096	1282	21787	0.6834	7.83683
360	smartengines-000	Russia	Commercial	288	275	197	0.7562	8.3518
361	securifai-003	Romania	Commercial	4104	546	1714	0.7577	8.5356
362	smilart-003	Germany	Commercial	512	2299	1395	0.8836	9.85531
363	intsysmsu-001	Russia	Academic	2048	1159	621	0.9888	10.97097
364	surrey-cvssp-000	United Kingdom	Academic	2048	1245	9557	0.9909	11.00741
365	facex-001	India	Commercial	2048	1670	1871	1	11.11777
366	corsight-001	Israel	Commercial	2064	1379	249340	0.0057	12.31136
367	veridium-000	United Kingdom	Commercial	29399	111	64880	0.1248	12.38472
368	cor-001	Israel	Commercial	2060	952	270145	0.0113	13.31651
369	sukshi-000	India	Commercial	32768	1574	9817	0.6612	15.16482
370	iqface-003	China	Commercial	4763	1694	575924	0.0079	28.39032
371	iqface-000	China	Commercial	4750	1393	636433	0.0143	31.35101
372	chosun-002	South Korea	Academic	2048	80302	623	0.0646	48.15956
373	shu-002	China	Academic	4096	3489	2930763	0.0079	144.07123

Although there are currently 416 algorithms in the NIST report, NIST did not report some metrics for all of them. If a submission was missing resource or accuracy data it was not possible to determine system performance and therefor the submission was omitted from the Visa images chart.

APPENDIX 3

NIST PERFORMANCE ON THE MUGSHOT IMAGE DATASET

Rank	Algorithm	Location	Commercial Academic	Template Size	Gen Time	Match Time	Accuracy (FNMR)	Performance (4D Magnitude)
1	dermalog-009	Germany	Commercial	512	389	487	0.0051	0.31802
2	cyberextruder-003	United States	Commercial	512	435	198	0.0071	0.34261
3	hertasecurity-001	Spain	Commercial	512	388	1770	0.0105	0.34432
4	maxvision-000	China	Commercial	512	370	2461	0.011	0.3494
5	idemia-007	France	Commercial	468	441	3243	0.0032	0.36391
6	dermalog-008	Germany	Commercial	512	477	468	0.0086	0.36685
7	neurotechnology-012	Lithuania	Commercial	256	583	119	0.0038	0.36711
8	idemia-008	France	Commercial	348	513	3080	0.0023	0.37148
9	csc-002	United States	Commercial	544	514	367	0.0077	0.38887
10	csc-003	United States	Commercial	544	535	393	0.0037	0.39165
11	acer-001	Taiwan	Commercial	512	259	2453	0.024	0.39332
12	rankone-011	United States	Commercial	261	682	283	0.0038	0.4247
13	rankone-012	United States	Commercial	261	695	273	0.0031	0.43149
14	kedacom-000	Singapore	Commercial	292	665	684	0.0111	0.43555
15	lookman-004	India	Commercial	548	656	871	0.0124	0.47452
16	visionlabs-010	Russia	Commercial	513	739	600	0.0026	0.491
17	visionlabs-011	Russia	Commercial	513	741	556	0.0024	0.49183
18	mvision-001	Russia	Commercial	512	710	1123	0.0204	0.52916
19	innovatrics-008	Slovakia	Commercial	538	853	3021	0.0038	0.57687
20	hertasecurity-000	Spain	Commercial	256	139	710	0.0503	0.58342
21	tevian-007	Russia	Commercial	1032	636	4894	0.0032	0.61539
22	tech5-004	Switzerland	Commercial	321	999	597	0.0086	0.62119
23	omnigarde-001	United States	Commercial	512	898	1405	0.0203	0.62441
24	deepsea-001	China	Commercial	1024	820	1401	0.0142	0.66598
25	bioidtechswiss-002	Switzerland	Commercial	512	1058	2177	0.0064	0.67964
26	vigilantsolutions-011	United States	Commercial	1548	445	339	0.0073	0.68558
27	afisbiometrics-000	United States	Commercial	512	1147	1400	0.003	0.72228
28	anyvision-005	Israel	Commercial	1024	995	733	0.0027	0.72771
29	hik-001	China	Commercial	1408	737	488	0.0093	0.72867
30	cogent-006	United States	Commercial	1062	971	1802	0.0036	0.72995
31	ptakuratsu-000	Indonesia	Commercial	538	1066	5900	0.007	0.73902
32	tevian-008	Russia	Commercial	1032	946	4828	0.0033	0.744
33	vigilantsolutions-010	United States	Commercial	1548	659	490	0.0074	0.74528
34	neurotechnology-013	Lithuania	Commercial	514	1195	109	0.0026	0.74662
35	upc-001	China	Academic	1052	863	3114	0.0291	0.76139
36	hyperverge-002	India	Commercial	1024	975	6023	0.0035	0.77612
37	vd-002	Finland	Commercial	516	754	300	0.0569	0.81211
38	deepsense-001	China	Commercial	512	1323	2356	0.0024	0.82839
39	id3-006	France	Commercial	520	1270	5547	0.0049	0.8375
40	tech5-005	Switzerland	Commercial	512	1351	2573	0.0069	0.84914
41	videmo-000	Germany	Commercial	2048	155	513	0.0155	0.85179
42	videmo-001	Germany	Commercial	2048	165	296	0.0164	0.85436
43	acer-002	Taiwan	Commercial	2048	186	3370	0.0103	0.85971
44	acisw-008	Thailand	Commercial	2048	336	1327	0.0094	0.86129
45	cogent-007	United States	Commercial	550	1390	355	0.0028	0.86333

APPENDIX 3

NIST PERFORMANCE ON THE MUGSHOT IMAGE DATASET

Rank	Algorithm	Location	Commercial Academic	Template Size	Gen Time	Match Time	Accuracy (FNMR)	Performance (4D Magnitude)
46	revealmedia-006	United Kingdom	Commercial	2052	394	626	0.0041	0.86448
47	chtface-004	Taiwan	Commercial	2048	377	1727	0.0052	0.86457
48	expasoft-001	Russia	Commercial	2048	74	1660	0.0211	0.86657
49	starhybrid-001	China	Commercial	2048	393	1075	0.0081	0.86741
50	siat-005	China	Academic	2048	422	577	0.0059	0.86891
51	intellivix-001	South Korea	Commercial	2048	421	1100	0.0046	0.86895
52	chtface-005	Taiwan	Commercial	2048	411	1907	0.0029	0.86967
53	omnigarde-002	United States	Commercial	1024	1261	2727	0.0027	0.8729
54	multimodality-000	China	Commercial	2048	463	848	0.0036	0.87533
55	sqisoft-002	South Korea	Commercial	2056	472	758	0.0051	0.88085
56	beethedata-000	Spain	Commercial	2048	467	2121	0.0092	0.88644
57	supremaid-001	South Korea	Commercial	2048	522	704	0.0045	0.8874
58	viettelhightech-000	Viet Nam	Commercial	2048	494	599	0.011	0.88866
59	incode-009	United States	Commercial	2048	537	1102	0.0034	0.89096
60	intsysmsu-002	Russia	Academic	1024	1293	549	0.0137	0.89277
61	sztu-001	China	Academic	2048	553	599	0.0025	0.89294
62	clova-000	South Korea	Commercial	2048	508	1794	0.0094	0.89304
63	rendip-000	Singapore	Commercial	2048	556	576	0.0048	0.89477
64	visionbox-002	Portugal	Commercial	2059	517	1969	0.006	0.89619
65	sztu-000	China	Academic	2048	548	585	0.0091	0.89725
66	facetag-002	South Korea	Commercial	2048	554	1730	0.0064	0.89918
67	ajou-001	South Korea	Academic	2048	577	597	0.0071	0.9015
68	cognitec-003	Germany	Commercial	2052	509	3417	0.0054	0.90193
69	advance-003	Singapore	Commercial	2048	591	1813	0.0052	0.90702
70	imperial-002	Great Britain	Academic	2048	588	2278	0.0055	0.90908
71	id3-008	France	Commercial	264	1433	5658	0.0032	0.91008
72	pangiam-000	United States	Commercial	2048	639	118	0.0026	0.91292
73	quantasoft-003	Czech Republic	Commercial	2048	634	201	0.0056	0.91342
74	kiwitech-000	China	Commercial	2048	609	1755	0.0081	0.9137
75	kuke3d-002	China	Commercial	2048	585	2943	0.0069	0.91419
76	winsense-002	China	Commercial	2048	634	1683	0.0038	0.91593
77	rokid-000	China	Commercial	2056	563	3457	0.0073	0.9169
78	intellcloudai-001	China	Commercial	2048	632	1056	0.0092	0.91804
79	mantra-000	India	Commercial	2052	598	3151	0.0054	0.91906
80	qnap-001	Taiwan	Commercial	2048	634	649	0.0103	0.9191
81	iit-003	Russia	Academic	2048	661	324	0.0053	0.92013
82	didiglobalface-001	China	Commercial	2048	666	973	0.003	0.92121
83	line-000	Japan	Commercial	2048	618	2753	0.0109	0.92545
84	cognitec-004	Germany	Commercial	2052	631	3028	0.0053	0.9259
85	imagus-005	Australia	Commercial	2048	411	731	0.0302	0.92933
86	ntechlab-011	Russia	Commercial	1280	1290	179	0.0024	0.93108
87	facesoft-000	Great Britain	Commercial	2048	687	2239	0.0064	0.9342
88	x-laboratory-000	China	Commercial	2056	673	725	0.0123	0.93511
89	ionetworks-000	Taiwan	Commercial	2048	444	6913	0.0044	0.93516

APPENDIX 3

NIST PERFORMANCE ON THE MUGSHOT IMAGE DATASET

Rank	Algorithm	Location	Commercial Academic	Template Size	Gen Time	Match Time	Accuracy (FNMR)	Performance (4D Magnitude)
90	imperial-000	Great Britain	Academic	2048	689	2130	0.008	0.93568
91	imagus-004	Australia	Commercial	2048	717	760	0.0055	0.93584
92	3divi-007	United States	Commercial	2048	727	707	0.0028	0.93699
93	scanovate-003	Israel	Commercial	2048	684	2926	0.0054	0.93719
94	advance-002	Singapore	Commercial	2048	718	987	0.0073	0.93819
95	iit-002	Russia	Academic	2048	733	1023	0.0085	0.94372
96	papsav1923-001	Turkey	Commercial	2048	744	725	0.0068	0.9444
97	armatura-001	United States	Commercial	2048	756	270	0.0031	0.94478
98	vd-003	Finalnd	Commercial	2052	722	1003	0.0115	0.94608
99	fincore-000	United Kingdom	Commercial	2048	535	1765	0.0281	0.94684
100	3divi-006	United States	Commercial	2048	759	775	0.0047	0.94716
101	mukh-001	United States	Commercial	1024	1360	433	0.0225	0.94928
102	aifirst-001	Thailand	Commercial	2048	755	1099	0.0084	0.95003
103	sertis-000	Thailand	Commercial	2048	763	1497	0.008	0.95319
104	winsense-001	China	Commercial	1280	1320	1631	0.0092	0.95469
105	androvideo-000	Taiwan	Commercial	2048	620	2860	0.0239	0.95723
106	x-laboratory-001	China	Commercial	2056	793	813	0.0054	0.96046
107	intellifusion-001	China	Commercial	2048	805	1112	0.0056	0.96212
108	faceonlive-001	Germany	Commercial	2056	343	1064	0.0387	0.96253
109	alphaface-002	China	Commercial	2048	828	945	0.003	0.96722
110	deepsense-000	China	Commercial	2048	808	480	0.0113	0.96811
111	anke-005	China	Commercial	2056	821	685	0.0059	0.96901
112	saffe-002	Germany	Commercial	2048	813	717	0.0107	0.9691
113	qnap-002	Taiwan	Commercial	2048	832	293	0.0075	0.97054
114	geo-002	Taiwan	Commercial	2048	803	3407	0.0035	0.97322
115	nazhai-000	China	Commercial	2048	834	2230	0.0036	0.9744
116	line-001	Japan	Commercial	2048	833	2696	0.0026	0.97653
117	s1-004	South Korea	Commercial	2048	828	3245	0.0038	0.97953
118	securifai-004	Romania	Commercial	2048	865	1711	0.0064	0.98337
119	netbridgetech-002	Taiwan	Commercial	2048	859	2893	0.0077	0.98932
120	twface-000	Taiwan	Commercial	2048	898	1504	0.0041	0.99159
121	ctbcbank-000	Taiwan	Commercial	2048	831	3551	0.0146	0.99576
122	nodeflux-002	Indonesia	Commercial	2048	736	3475	0.0261	0.99811
123	sensetime-005	China	Commercial	1028	1514	1223	0.0022	1.00052
124	cubox-001	South Korea	Commercial	2048	931	1379	0.0037	1.00184
125	twface-001	Taiwan	Commercial	2048	940	1400	0.0031	1.00467
126	sensetime-006	China	Commercial	1028	1523	1179	0.0021	1.00526
127	isap-002	Taiwan	Commercial	2048	912	3045	0.0087	1.00835
128	alchera-003	South Korea	Commercial	2048	918	3426	0.0031	1.0091
129	authenmetric-004	China	Commercial	2048	950	1724	0.0033	1.00933
130	ceiec-003	China	Commercial	2048	944	2256	0.0061	1.0115
131	rokid-001	China	Commercial	2060	901	3345	0.0094	1.01188
132	kakao-007	South Korea	Commercial	2048	968	1056	0.0024	1.01293
133	yoontik-003	Portugal	Commercial	2048	983	684	0.0032	1.01762

APPENDIX 3

NIST PERFORMANCE ON THE MUGSHOT IMAGE DATASET

Rank	Algorithm	Location	Commercial Academic	Template Size	Gen Time	Match Time	Accuracy (FNMR)	Performance (4D Magnitude)
134	anke-004	China	Commercial	2056	982	633	0.0073	1.02251
135	facephi-000	Spain	Commercial	2048	949	4067	0.0047	1.0258
136	hyperverge-003	India	Commercial	1024	1565	566	0.0025	1.02639
137	meituan-001	China	Commercial	2048	1011	654	0.0025	1.02714
138	cubox-002	South Korea	Commercial	2048	1003	2008	0.0025	1.02856
139	vocord-010	Russia	Commercial	1088	1535	2724	0.0036	1.02964
140	authenmetric-003	China	Commercial	2048	1036	1757	0.0039	1.0397
141	vts-001	Viet Nam	Commercial	2048	709	9620	0.0027	1.04448
142	t4isb-000	Brazil	Commercial	2048	1022	3586	0.0041	1.04615
143	alleyes-000	China	Commercial	2048	1057	1298	0.0055	1.04657
144	ceiec-004	China	Commercial	2048	1055	1844	0.0045	1.04722
145	innovativetechnologyltd-001	Great Britain	Commercial	2048	485	1877	0.0501	1.04774
146	alchera-002	South Korea	Commercial	2048	1025	3488	0.0104	1.05194
147	knowutech-000	United States	Commercial	1536	1386	3743	0.0028	1.05411
148	via-000	Taiwan	Commercial	2048	1040	966	0.0177	1.05671
149	kakao-005	South Korea	Commercial	2052	1089	2067	0.0036	1.06147
150	ctbcbank-001	Taiwan	Commercial	2048	1030	3926	0.0148	1.06405
151	kookmin-002	South Korea	Academic	2048	1116	638	0.0043	1.06621
152	pixelall-007	China	Commercial	2048	1124	708	0.0039	1.06914
153	yoonik-002	Portugal	Commercial	2048	1126	761	0.0029	1.06958
154	cybercore-002	Japan	Commercial	2048	528	12389	0.0049	1.07694
155	vinai-000	Viet Nam	Commercial	2048	1126	2996	0.0045	1.07972
156	via-001	Taiwan	Commercial	2048	1137	983	0.0114	1.08136
157	fiberhome-nanjing-003	China	Commercial	2048	1154	1097	0.0082	1.08441
158	wuhantianyu-001	China	Commercial	2048	697	9502	0.0281	1.08574
159	regula-000	United States	Commercial	2048	1159	491	0.0103	1.08753
160	decaturn-001	United States	Commercial	2052	1084	610	0.0237	1.08772
161	hzailu-001	China	Commercial	2056	1159	894	0.0095	1.08969
162	bresee-002	China	Commercial	2048	1176	1778	0.0065	1.09358
163	xforwardai-001	China	Commercial	2048	1203	779	0.0027	1.09927
164	bioidtechswiss-001	Switzerland	Commercial	512	1793	2610	0.0069	1.10502
165	tiger-005	United States	Commercial	2052	1088	620	0.0292	1.10601
166	incode-010	United States	Commercial	2048	1221	1164	0.0028	1.10723
167	sertis-002	Thailand	Commercial	2048	1221	1086	0.0039	1.10746
168	scanovate-002	Israel	Commercial	2048	1172	3021	0.0146	1.10846
169	mobbl-003	Spain	Commercial	2048	691	12506	0.0062	1.1136
170	innefulabs-000	India	Commercial	2048	1135	5782	0.0112	1.11604
171	regula-001	United States	Commercial	2048	1255	361	0.0102	1.12494
172	innovativetechnologyltd-002	Great Britain	Commercial	2048	766	1841	0.0541	1.12995
173	seventhsense-000	Singapore	Commercial	2052	1272	1800	0.0045	1.13158
174	geo-004	Taiwan	Commercial	2048	1296	1023	0.0025	1.13705
175	seventhsense-001	Singapore	Commercial	2052	1288	1936	0.0025	1.13783
176	lemalabs-001	India	Commercial	2048	844	11930	0.0088	1.13819

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NIST PERFORMANCE ON THE MUGSHOT IMAGE DATASET

Rank	Algorithm	Location	Commercial Academic	Template Size	Gen Time	Match Time	Accuracy (FNMR)	Performance (4D Magnitude)
177	cloudwalk-hr-004	China	Commercial	2049	902	11652	0.0034	1.14383
178	realnetworks-005	United States	Commercial	2056	1312	1213	0.0063	1.14827
179	cloudwalk-mt-004	China	Commercial	2048	927	11744	0.0024	1.15264
180	synology-002	Taiwan	Commercial	2048	1317	1466	0.0107	1.15283
181	pxl-001	Switzerland	Commercial	512	1470	5598	0.0586	1.15401
182	hisign-001	China	Commercial	2080	1325	201	0.0034	1.1576
183	ivacognitive-001	Russia	Commercial	2048	1321	4228	0.0123	1.17281
184	insightface-001	China	Commercial	2048	1386	1119	0.0027	1.17485
185	tinkoff-001	Russia	Commercial	2048	1203	4361	0.0318	1.17493
186	dahua-006	China	Commercial	2048	1402	249	0.0031	1.18057
187	insightface-002	China	Commercial	2048	1413	1169	0.0027	1.18648
188	clearviewai-000	United States	Commercial	2048	1418	1592	0.0024	1.18972
189	kneron-003	United States	Commercial	2048	1224	5237	0.0346	1.20113
190	f8-002	Taiwan	Commercial	2048	702	14765	0.0213	1.20299
191	intelresearch-004	Iceland	Academic	2048	1411	4696	0.0032	1.20667
192	toshiba-005	Japan	Commercial	2056	1459	1613	0.0024	1.2097
193	intelresearch-005	Iceland	Commercial	2048	1423	4524	0.0028	1.21001
194	pixelall-006	China	Commercial	2560	1054	754	0.0032	1.21389
195	toshiba-004	Japan	Commercial	2056	1479	1020	0.0025	1.21688
196	aware-006	United States	Commercial	352	1754	2598	0.0529	1.22398
197	remarkai-001	China	Commercial	2052	1519	1229	0.0102	1.23886
198	vnpt-004	Viet Nam	Commercial	2048	1505	4047	0.0037	1.2415
199	deepglint-004	China	Commercial	2048	1492	5961	0.0039	1.2545
200	cloudwalk-mt-005	China	Commercial	2048	1229	12525	0.0025	1.26827
201	aize-001	Japan	Commercial	2048	1583	1937	0.0199	1.28296
202	papsav1923-002	Turkey	Commercial	2052	1641	1209	0.0026	1.28875
203	aiunionface-000	Taiwan	Commercial	2048	1639	1072	0.0082	1.28949
204	expasoft-002	Russia	Commercial	2048	34	8870	0.0787	1.28967
205	daon-000	Ireland	Commercial	2065	1055	16052	0.0068	1.31363
206	intellivision-002	United States	Commercial	2056	600	13525	0.061	1.31729
207	mobai-001	Norway	Commercial	2048	1707	1386	0.0047	1.31936
208	turingtechvip-001	China	Commercial	2048	1476	1733	0.0458	1.32013
209	notiontag-002	India	Commercial	2120	471	20278	0.0045	1.34554
210	kneron-005	United States	Commercial	2048	1760	1922	0.0126	1.35219
211	ntechlab-012	Russia	Commercial	2560	1460	211	0.0023	1.35593
212	intellivision-003	United States	Commercial	2056	591	11069	0.076	1.3589
213	icthtc-000	China	Academic	2048	1719	5284	0.0207	1.36745
214	tiger-006	United States	Commercial	2052	1848	1810	0.005	1.38824
215	yuan-003	Taiwan	Commercial	2048	1878	2320	0.0062	1.40411
216	innovatrics-007	Slovakia	Commercial	1064	2210	5978	0.0057	1.42525
217	maxvision-001	China	Commercial	2048	325	714	0.1028	1.43799
218	samsungsds-000	South Korea	Commercial	2048	343	23722	0.0132	1.45244
219	irex-000	United States	Commercial	3080	1249	201	0.0056	1.4546
220	vocord-009	Russia	Commercial	1920	2064	2052	0.0036	1.46492
221	mobipintech-000	South Korea	Commercial	2048	1707	14506	0.0039	1.49783

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NIST PERFORMANCE ON THE MUGSHOT IMAGE DATASET

Rank	Algorithm	Location	Commercial Academic	Template Size	Gen Time	Match Time	Accuracy (FNMR)	Performance (4D Magnitude)
222	visage-000	Sweden	Commercial	512	63	2220	0.1316	1.50229
223	enface-000	Russia	Commercial	1024	2349	7059	0.0043	1.50923
224	synesis-007	Russia	Commercial	3080	1423	684	0.0062	1.5116
225	eocortex-000	Russia	Commercial	2048	513	923	0.1122	1.5434
226	enface-001	Russia	Commercial	1024	2416	6734	0.0071	1.54459
227	smilart-003	Germany	Commercial	512	2299	1395	0.0695	1.60044
228	sktelecom-000	South Korea	Commercial	1536	1155	26583	0.0031	1.60424
229	aware-005	United States	Commercial	1572	2195	1475	0.0603	1.61349
230	sjt-003	China	Academic	2048	2373	1560	0.003	1.64837
231	xm-000	China	Academic	2052	2434	1634	0.0031	1.68103
232	revealmedia-005	United Kingdom	Commercial	4100	442	2023	0.005	1.68275
233	icm-003	Australia	Commercial	2048	1381	24351	0.0149	1.68286
234	verihubs-inteligensia-000	Indonesia	Commercial	2048	1621	22351	0.0048	1.68526
235	suprema-001	South Korea	Commercial	2048	2443	3212	0.0038	1.69057
236	kakaopay-001	South Korea	Commercial	4096	553	633	0.0145	1.69724
237	paravision-010	United States	Commercial	4100	635	1577	0.0022	1.70292
238	corsight-002	Israel	Commercial	2080	1388	24953	0.003	1.70447
239	synesis-006	Russia	Commercial	4104	639	697	0.0107	1.7077
240	paravision-008	United States	Commercial	4096	702	337	0.0024	1.70914
241	suprema-002	South Korea	Commercial	2048	2479	3255	0.0034	1.7094
242	yuan-004	Taiwan	Commercial	4096	607	5816	0.0039	1.7202
243	camvi-002	United States	Commercial	1024	2785	612	0.0089	1.72357
244	intellcloudai-002	China	Commercial	4100	878	822	0.006	1.74118
245	closeli-001	China	Commercial	4096	865	5404	0.0039	1.75626
246	xforwardai-002	China	Commercial	4096	967	1406	0.0026	1.75636
247	allgovision-000	India	Commercial	2048	710	29903	0.0232	1.75939
248	kuke3d-001	China	Commercial	4096	834	6412	0.0083	1.761
249	s1-003	South Korea	Commercial	4096	955	3657	0.0044	1.76228
250	remarkai-003	China	Commercial	4100	1019	787	0.0033	1.76763
251	sodec-000	Turkey	Commercial	4096	1061	1794	0.004	1.77693
252	minivision-000	China	Commercial	4096	1059	2466	0.0038	1.77839
253	fujitsulab-003	China	Commercial	4104	1045	2855	0.0057	1.78048
254	itmo-008	Russia	Academic	4096	1104	3578	0.0058	1.79342
255	intellifusion-002	China	Commercial	4096	1171	1713	0.004	1.80141
256	aimall-003	China	Commercial	1024	807	34565	0.0033	1.81468
257	verigram-001	Kazakhstan	Commercial	2048	2733	1664	0.0027	1.83807
258	fiberhome-nanjing-004	China	Commercial	4096	1326	1276	0.0031	1.83854
259	fujitsulab-002	China	Commercial	4104	1327	2836	0.0105	1.84938
260	dahua-007	China	Commercial	4096	1379	367	0.0026	1.85143
261	psl-009	Singapore	Commercial	4168	1385	316	0.0023	1.87904
262	uluface-002	China	Commercial	2048	2333	19207	0.0071	1.88149
263	psl-010	Singapore	Commercial	4168	1396	354	0.0023	1.88198
264	verigram-000	Kazakhstan	Commercial	2048	2848	1222	0.0031	1.89907
265	vnpt-003	Viet Nam	Commercial	4096	1428	7397	0.004	1.90007

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Rank	Algorithm	Location	Commercial Academic	Template Size	Gen Time	Match Time	Accuracy (FNMR)	Performance (4D Magnitude)
266	camvi-004	United States	Commercial	2048	2891	948	0.0042	1.92217
267	megvii-005	China	Commercial	2049	1298	32025	0.0026	1.94178
268	faceX-002	India	Commercial	2048	1738	631	0.1283	1.96578
269	alice-000	Spain	Commercial	4096	1264	14975	0.0106	1.96808
270	digitalbarriers-002	Great Britain	Commercial	2056	2236	13409	0.0877	1.97488
271	vinbigdata-001	Viet Nam	Commercial	2048	1404	1351	0.1404	1.97576
272	visteam-003	Portugal	Academic	4096	1370	6816	0.0613	2.00186
273	shu-003	China	Academic	2048	3045	2506	0.005	2.00931
274	meituan-000	China	Commercial	2048	3126	638	0.0078	2.05119
275	ytu-000	China	Commercial	2048	1949	31797	0.0121	2.12422
276	toppanidgate-000	Taiwan	Commercial	4096	917	25262	0.0026	2.14191
277	bresee-001	China	Commercial	2048	1360	37240	0.0086	2.1703
278	adera-002	Singapore	Commercial	5120	1464	2163	0.0047	2.25179
279	adera-003	Singapore	Commercial	5120	1469	2148	0.0036	2.25266
280	ekin-002	Turkey	Commercial	3072	1207	4294	0.153	2.25517
281	kasikornlabs-000	Thailand	Commercial	2048	2382	31669	0.0086	2.27105
282	uluface-003	China	Commercial	3072	2469	26057	0.0079	2.32002
283	20face-001	Netherlands	Commercial	4096	267	5553	0.1414	2.32029
284	nsensecorp-003	South Korea	Commercial	2048	659	44658	0.0212	2.39096
285	sjt-004	China	Academic	4608	2738	3057	0.0027	2.48799
286	sqisoft-001	South Korea	Commercial	2056	1393	797	0.1978	2.52226
287	visteam-002	Portugal	Academic	4096	1013	6952	0.1581	2.53078
288	cyberlink-008	Taiwan	Commercial	6212	760	263	0.0038	2.55319
289	cyberlink-007	Taiwan	Commercial	6212	767	304	0.0041	2.55401
290	gorilla-007	Taiwan	Commercial	6288	722	3686	0.0065	2.58651
291	cloudmatrix-000	Taiwan	Commercial	2048	793	49192	0.0133	2.60383
292	canon-004	Japan	Commercial	6200	1064	7172	0.0033	2.61101
293	canon-003	Japan	Commercial	6180	1482	4783	0.003	2.66275
294	cloudmatrix-001	Taiwan	Commercial	2048	169	50263	0.0539	2.67734
295	deepglint-003	China	Commercial	6144	1163	17227	0.003	2.71589
296	neosystems-003	Canada	Commercial	2048	2273	19130	0.1844	2.78351
297	aize-002	Japan	Commercial	2048	4617	597	0.028	2.90679
298	beyneai-000	Kazakhstan	Commercial	2048	4669	3730	0.0104	2.92743
299	neosystems-002	Canada	Commercial	2048	2247	18752	0.2028	2.92855
300	megvii-004	China	Commercial	4097	1436	46801	0.0028	2.96274
301	synology-000	Taiwan	Commercial	2048	4568	19720	0.0148	3.02562
302	digidata-000	India	Commercial	2048	380	2084	0.2596	3.0515
303	20face-000	Netherlands	Commercial	2048	224	44880	0.1748	3.07444
304	nhn-003	South Korea	Commercial	4096	1375	50560	0.0027	3.09821
305	samsungsds-001	South Korea	Commercial	4096	1514	51559	0.0023	3.16061
306	wicket-000	United States	Commercial	2048	1537	60976	0.0024	3.24307
307	mendaxiatech-000	China	Commercial	4097	2689	46906	0.0029	3.26493
308	oz-004	Russia	Commercial	2053	1608	61654	0.0038	3.2868
309	nhn-002	South Korea	Commercial	4096	1203	56608	0.0057	3.3179
310	openface-001	South Korea	Commercial	2048	616	608	0.2878	3.3687

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Rank	Algorithm	Location	Commercial Academic	Template Size	Gen Time	Match Time	Accuracy (FNMR)	Performance (4D Magnitude)
311	aigen-002	Thailand	Commercial	2048	5427	3678	0.0256	3.37484
312	mobai-000	Norway	Commercial	6144	3549	16458	0.0372	3.39557
313	gorilla-008	Taiwan	Commercial	8338	720	4530	0.0049	3.40669
314	pensees-001	Singapore	Commercial	8200	1546	3151	0.0071	3.44718
315	boetech-002	China	Commercial	2048	348	68921	0.0114	3.49581
316	boetech-001	China	Commercial	2048	318	68519	0.0493	3.51743
317	aigen-001	Thailand	Commercial	2048	5691	3772	0.0143	3.51982
318	visionbox-001	Portugal	Commercial	2048	5955	1161	0.0111	3.66783
319	aimall-002	China	Commercial	2048	1003	72811	0.0224	3.73067
320	awiros-002	India	Commercial	2048	946	1966	0.3319	3.87486
321	asusaics-000	Taiwan	Commercial	2048	6305	5455	0.0085	3.88042
322	veridas-007	Spain	Commercial	2048	6374	655	0.0044	3.91083
323	griaule-000	United States	Commercial	2052	6406	3987	0.005	3.93477
324	omsecurity-000	South Korea	Commercial	1024	193	481	0.359	4.06968
325	oz-003	Russia	Commercial	2053	3209	73905	0.0054	4.19395
326	ayfttech-001	China	Commercial	512	5412	615	0.2438	4.25747
327	luxand-000	United States	Commercial	1040	562	828	0.4053	4.60061
328	asusaics-001	Taiwan	Commercial	4096	7284	8618	0.0085	4.69095
329	veridas-006	Spain	Commercial	2048	6414	56940	0.0079	4.82857
330	cudocommunication-001	South Korea	Commercial	2048	964	2534	0.4373	5.0334
331	graymatics-001	United States	Commercial	4096	7150	39874	0.1344	5.22085
332	netbridgetech-001	Taiwan	Commercial	4096	113	9280	0.4438	5.28991
333	glory-003	Japan	Commercial	4234	8941	6020	0.0077	5.63598
334	dps-000	France	Commercial	4096	9345	1473	0.0149	5.84555
335	glory-004	Japan	Commercial	4182	9360	4982	0.0074	5.86696
336	antheus-001	Brazil	Commercial	520	2660	6218	0.5113	5.99173
337	ailabs-001	Taiwan	Commercial	2048	5205	104034	0.0192	6.05122
338	vts-000	Viet Nam	Commercial	2048	517	124209	0.008	6.16921
339	unissey-001	France	Commercial	4096	10017	1463	0.0134	6.23237
340	awiros-001	India	Commercial	512	556	1079	0.553	6.24627
341	techsign-000	Turkey	Commercial	2048	10460	4758	0.0435	6.34928
342	farfaces-001	United Kingdom	Commercial	512	1209	855	0.565	6.41358
343	euronovate-001	Switzerland	Commercial	1177	1172	81294	0.4489	6.50316
344	mobbl-001	Spain	Commercial	2048	2781	11832	0.568	6.69329
345	facetag-000	South Korea	Commercial	684	7930	72003	0.2933	6.79252
346	chosun-001	South Korea	Academic	2048	11694	998	0.0742	7.10972
347	videonetics-002	India	Commercial	2052	3151	1219	0.6081	7.15891
348	dsk-000	China	Commercial	512	10451	7152	0.3787	7.59308
349	alfabeta-001	Indonesia	Commercial	512	2547	470	0.6855	7.87953
350	iws-000	United States	Commercial	512	2987	999	0.6859	7.93939
351	nsensecorp-002	South Korea	Commercial	2048	351	45965	0.6734	7.96593
352	antheus-000	Brazil	Commercial	520	236	6901	0.724	8.17229
353	cybercore-001	Japan	Commercial	2048	502	52119	0.6928	8.2661
354	securifai-003	Romania	Commercial	4104	546	1714	0.7233	8.32744

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NIST PERFORMANCE ON THE MUGSHOT IMAGE DATASET

Rank	Algorithm	Location	Commercial Academic	Template Size	Gen Time	Match Time	Accuracy (FNMR)	Performance (4D Magnitude)
355	videonetics-001	India	Commercial	512	2393	1153	0.7517	8.59686
356	biocube-001	India	Commercial	4096	1282	21787	0.77	8.93422
357	dicio-001	Mexico	Commercial	520	5286	2818	0.7516	9.04933
358	acisw-007	Thailand	Commercial	2048	484	1316	0.8425	9.53778
359	realnetworks-006	United States	Commercial	2056	774	469	0.8657	9.80499
360	lebentech-000	Mexico	Commercial	512	23	801	0.8854	9.98294
361	smartengines-000	Russia	Commercial	288	275	197	0.9552	10.76942
362	intsysmsu-001	Russia	Academic	2048	1159	621	0.9923	11.23789
363	surrey-cvssp-000	United Kingdom	Academic	2048	1245	9557	0.9923	11.25097
364	coretech-000	Taiwan	Commercial	512	1165	333	1	11.29606
365	moredian-000	China	Commercial	2048	713	1803	0.9988	11.29786
366	facex-001	India	Commercial	2048	1670	1871	1	11.34755
367	corsight-001	Israel	Commercial	2064	1379	249340	0.0033	12.31125
368	cor-001	Israel	Commercial	2060	952	270145	0.0055	13.31607
369	veridium-000	United Kingdom	Commercial	29399	111	64880	0.5226	13.64502
370	sukshi-000	India	Commercial	32768	1574	9817	0.4556	14.24961
371	iqface-003	China	Commercial	4763	1694	575924	0.0051	28.39024
372	iqface-000	China	Commercial	4750	1393	636433	0.0075	31.35072
373	chosun-002	South Korea	Academic	2048	80302	623	0.0339	48.1558
374	shu-002	China	Academic	4096	3489	2930763	0.0146	144.0713

Although there are currently 416 algorithms in the NIST report, NIST did not report some metrics for all of them. If a submission was missing resource or accuracy data, it was not possible to determine system performance and therefore the submission was omitted from the Mugshot images chart.

APPENDIX 4

NIST PERFORMANCE ON THE WILD IMAGE DATASET

Rank	Algorithm	Location	Commercial Academic	Template Size	Gen Time	Match Time	Accuracy (FNMR)	Performance (4D Magnitude)
1	dermalog-009	Germany	Commercial	512	389	487	0.03	0.37303
2	acer-001	Taiwan	Commercial	512	259	2453	0.0391	0.38949
3	cyberextruder-003	United States	Commercial	512	435	198	0.0332	0.40198
4	dermalog-008	Germany	Commercial	512	477	468	0.0311	0.41182
5	idemia-007	France	Commercial	468	441	3243	0.0309	0.41829
6	neurotechnology-012	Lithuania	Commercial	256	583	119	0.0306	0.41944
7	idemia-008	France	Commercial	348	513	3080	0.0304	0.42398
8	hertasecurity-000	Spain	Commercial	256	139	710	0.0651	0.46202
9	hertasecurity-001	Spain	Commercial	512	388	1770	0.0533	0.48475
10	maxvision-000	China	Commercial	512	370	2461	0.0551	0.49609
11	rankone-011	United States	Commercial	261	682	283	0.0384	0.49623
12	rankone-012	United States	Commercial	261	695	273	0.038	0.50126
13	visionlabs-011	Russia	Commercial	513	741	556	0.0303	0.53228
14	visionlabs-010	Russia	Commercial	513	739	600	0.0307	0.53244
15	mvision-001	Russia	Commercial	512	710	1123	0.0476	0.57546
16	visage-000	Sweden	Commercial	512	63	2220	0.0827	0.60845
17	innovatrics-008	Slovakia	Commercial	538	853	3021	0.031	0.61242
18	omnigarde-001	United States	Commercial	512	898	1405	0.0331	0.62276
19	tech5-004	Switzerland	Commercial	321	999	597	0.0311	0.64876
20	tevia-007	Russia	Commercial	1032	636	4894	0.0329	0.65353
21	vd-002	Finland	Commercial	516	754	300	0.0711	0.69299
22	deepsea-001	China	Commercial	1024	820	1401	0.0385	0.69711
23	bioidtechswiss-002	Switzerland	Commercial	512	1058	2177	0.031	0.7077
24	vigilantsolutions-011	United States	Commercial	1548	445	339	0.0323	0.71495
25	upc-001	China	Academic	1052	863	3114	0.0367	0.73072
26	afisbiometrics-000	United States	Commercial	512	1147	1400	0.0303	0.75013
27	hik-001	China	Commercial	1408	737	488	0.0307	0.75049
28	anyvision-005	Israel	Commercial	1024	995	733	0.0303	0.75551
29	ptakuratsatu-000	Indonesia	Commercial	538	1066	5900	0.0312	0.7646
30	cogent-006	United States	Commercial	1062	971	1802	0.0372	0.77118
31	tevia-008	Russia	Commercial	1032	946	4828	0.0309	0.772
32	neurotechnology-013	Lithuania	Commercial	514	1195	109	0.0301	0.77342
33	vigilantsolutions-010	United States	Commercial	1548	659	490	0.033	0.77362
34	hyperverge-002	India	Commercial	1024	975	6023	0.0302	0.80168
35	deepsense-001	China	Commercial	512	1323	2356	0.0303	0.85302
36	acer-002	Taiwan	Commercial	2048	186	3370	0.0339	0.88226
37	tech5-005	Switzerland	Commercial	512	1351	2573	0.0381	0.88411
38	revealmedia-006	United Kingdom	Commercial	2052	394	626	0.0303	0.88732
39	siat-005	China	Academic	2048	422	577	0.0303	0.89035
40	imagus-005	Australia	Commercial	2048	411	731	0.0317	0.89101
41	chtface-004	Taiwan	Commercial	2048	377	1727	0.0334	0.89178
42	omnigarde-002	United States	Commercial	1024	1261	2727	0.0302	0.89605
43	chtface-005	Taiwan	Commercial	2048	411	1907	0.0328	0.89703
44	multimodality-000	China	Commercial	2048	463	848	0.031	0.89926
45	starhybrid-001	China	Commercial	2048	393	1075	0.039	0.90216

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Rank	Algorithm	Location	Commercial Academic	Template Size	Gen Time	Match Time	Accuracy (FNMR)	Performance (4D Magnitude)
46	intellivix-001	South Korea	Commercial	2048	421	1100	0.0376	0.90405
47	sqisoft-002	South Korea	Commercial	2056	472	758	0.0322	0.90565
48	beethedata-000	Spain	Commercial	2048	467	2121	0.0314	0.9057
49	intsysmsu-002	Russia	Academic	1024	1293	549	0.0329	0.90713
50	digidata-000	India	Commercial	2048	380	2084	0.0404	0.90724
51	sztu-000	China	Academic	2048	548	585	0.0304	0.91486
52	sztu-001	China	Academic	2048	553	599	0.0299	0.91521
53	clova-000	South Korea	Commercial	2048	508	1794	0.0337	0.91566
54	incode-009	United States	Commercial	2048	537	1102	0.032	0.91617
55	cogent-007	United States	Commercial	550	1390	355	0.0461	0.91756
56	supremaid-001	South Korea	Commercial	2048	522	704	0.0376	0.92185
57	videmo-000	Germany	Commercial	2048	155	513	0.0601	0.92783
58	imperial-002	Great Britain	Academic	2048	588	2278	0.0303	0.92991
59	kiwitech-000	China	Commercial	2048	609	1755	0.031	0.93308
60	ajou-001	South Korea	Academic	2048	577	597	0.0378	0.93376
61	cognitec-003	Germany	Commercial	2052	509	3417	0.0376	0.93525
62	expasoft-001	Russia	Commercial	2048	74	1660	0.0635	0.93782
63	viettelhightech-000	Viet Nam	Commercial	2048	494	599	0.0482	0.93862
64	kuke3d-002	China	Commercial	2048	585	2943	0.0335	0.93874
65	winsense-002	China	Commercial	2048	634	1683	0.0334	0.9425
66	didiglobalface-001	China	Commercial	2048	666	973	0.0308	0.94395
67	line-000	Japan	Commercial	2048	618	2753	0.0337	0.94525
68	mukh-001	United States	Commercial	1024	1360	433	0.0358	0.94639
69	rendip-000	Singapore	Commercial	2048	556	576	0.0462	0.94641
70	faceonlive-001	Germany	Commercial	2056	343	1064	0.0598	0.94886
71	visionbox-002	Portugal	Commercial	2059	517	1969	0.0475	0.94983
72	x-laboratory-000	China	Commercial	2056	673	725	0.0328	0.95111
73	mantra-000	India	Commercial	2052	598	3151	0.0378	0.95214
74	ntechlab-011	Russia	Commercial	1280	1290	179	0.0305	0.95336
75	facesoft-000	Great Britain	Commercial	2048	687	2239	0.0304	0.95392
76	imperial-000	Great Britain	Academic	2048	689	2130	0.0308	0.95442
77	imagus-004	Australia	Commercial	2048	717	760	0.0311	0.95727
78	qnap-001	Taiwan	Commercial	2048	634	649	0.0436	0.95841
79	scanovate-003	Israel	Commercial	2048	684	2926	0.0311	0.95866
80	quantasoft-003	Czech Republic	Commercial	2048	634	201	0.0441	0.95898
81	cognitec-004	Germany	Commercial	2052	631	3028	0.0379	0.95899
82	pangiam-000	United States	Commercial	2048	639	118	0.0447	0.96141
83	3divi-007	United States	Commercial	2048	727	707	0.0326	0.96216
84	innovativetechnologyltd-001	Great Britain	Commercial	2048	485	1877	0.0568	0.96278
85	ionetworks-000	Taiwan	Commercial	2048	444	6913	0.0347	0.96299
86	intellicloudai-001	China	Commercial	2048	632	1056	0.0462	0.96438
87	iit-003	Russia	Academic	2048	661	324	0.0439	0.96517
88	papsav1923-001	Turkey	Commercial	2048	744	725	0.0325	0.9667
89	3divi-006	United States	Commercial	2048	759	775	0.0319	0.97006

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Rank	Algorithm	Location	Commercial Academic	Template Size	Gen Time	Match Time	Accuracy (FNMR)	Performance (4D Magnitude)
90	sertis-000	Thailand	Commercial	2048	763	1497	0.0318	0.97308
91	expasoft-002	Russia	Commercial	2048	34	8870	0.0396	0.97377
92	advance-003	Singapore	Commercial	2048	591	1813	0.0537	0.97553
93	winsense-001	China	Commercial	1280	1320	1631	0.0352	0.97855
94	vd-003	Finland	Commercial	2052	722	1003	0.0423	0.98001
95	maxvision-001	China	Commercial	2048	325	714	0.0717	0.9803
96	x-laboratory-001	China	Commercial	2056	793	813	0.0323	0.9832
97	nodeflux-002	Indonesia	Commercial	2048	736	3475	0.0355	0.98363
98	intellifusion-001	China	Commercial	2048	805	1112	0.0326	0.98514
99	deepsense-000	China	Commercial	2048	808	480	0.0331	0.98555
100	alphaface-002	China	Commercial	2048	828	945	0.0305	0.98847
101	anke-005	China	Commercial	2056	821	685	0.0314	0.98987
102	saffe-002	Germany	Commercial	2048	813	717	0.0352	0.9907
103	nazhai-000	China	Commercial	2048	834	2230	0.03	0.99455
104	line-001	Japan	Commercial	2048	833	2696	0.0304	0.99759
105	geo-002	Taiwan	Commercial	2048	803	3407	0.0329	0.99764
106	aifirst-001	Thailand	Commercial	2048	755	1099	0.0477	0.99903
107	s1-004	South Korea	Commercial	2048	828	3245	0.0308	1.0006
108	advance-002	Singapore	Commercial	2048	718	987	0.0533	1.00193
109	qnap-002	Taiwan	Commercial	2048	832	293	0.0411	1.00616
110	twface-000	Taiwan	Commercial	2048	898	1504	0.0303	1.01156
111	securifai-004	Romania	Commercial	2048	865	1711	0.0393	1.01623
112	facetag-002	South Korea	Commercial	2048	554	1730	0.0707	1.01628
113	netbridgetech-002	Taiwan	Commercial	2048	859	2893	0.0385	1.01945
114	sensetime-005	China	Commercial	1028	1514	1223	0.0299	1.02052
115	twface-001	Taiwan	Commercial	2048	940	1400	0.03	1.02443
116	cubox-001	South Korea	Commercial	2048	931	1379	0.0326	1.02505
117	sensetime-006	China	Commercial	1028	1523	1179	0.0299	1.0252
118	authenmetric-004	China	Commercial	2048	950	1724	0.0311	1.03043
119	fincore-000	United Kingdom	Commercial	2048	535	1765	0.0772	1.03432
120	ceiec-003	China	Commercial	2048	944	2256	0.0337	1.03467
121	rokid-001	China	Commercial	2060	901	3345	0.0363	1.03594
122	isap-002	Taiwan	Commercial	2048	912	3045	0.039	1.03778
123	alchera-003	South Korea	Commercial	2048	918	3426	0.0363	1.03805
124	anke-004	China	Commercial	2056	982	633	0.032	1.042
125	hyperverge-003	India	Commercial	1024	1565	566	0.0302	1.04621
126	facephi-000	Spain	Commercial	2048	949	4067	0.0332	1.04884
127	vocord-010	Russia	Commercial	1088	1535	2724	0.0301	1.04886
128	kakao-007	South Korea	Commercial	2048	968	1056	0.0446	1.05671
129	authenmetric-003	China	Commercial	2048	1036	1757	0.0313	1.0602
130	alleyes-000	China	Commercial	2048	1057	1298	0.0306	1.06511
131	t4isb-000	Brazil	Commercial	2048	1022	3586	0.0307	1.06563
132	wuhantianyu-001	China	Commercial	2048	697	9502	0.0368	1.06803
133	alchera-002	South Korea	Commercial	2048	1025	3488	0.0354	1.07255
134	vts-001	Viet Nam	Commercial	2048	709	9620	0.0364	1.07278

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Rank	Algorithm	Location	Commercial Academic	Template Size	Gen Time	Match Time	Accuracy (FNMR)	Performance (4D Magnitude)
135	knowutech-000	United States	Commercial	1536	1386	3743	0.0298	1.07282
136	ceiec-004	China	Commercial	2048	1055	1844	0.0357	1.07359
137	via-000	Taiwan	Commercial	2048	1040	966	0.0426	1.0771
138	decaturn-001	United States	Commercial	2052	1084	610	0.0329	1.07771
139	tiger-005	United States	Commercial	2052	1088	620	0.0329	1.07917
140	cupbox-002	South Korea	Commercial	2048	1003	2008	0.0486	1.07962
141	kakao-005	South Korea	Commercial	2052	1089	2067	0.0307	1.0809
142	kookmin-002	South Korea	Academic	2048	1116	638	0.031	1.08563
143	pixelall-007	China	Commercial	2048	1124	708	0.0308	1.08843
144	rokid-000	China	Commercial	2056	563	3457	0.0889	1.09399
145	vinai-000	Viet Nam	Commercial	2048	1126	2996	0.0302	1.09777
146	fiberhome-nanjing-003	China	Commercial	2048	1154	1097	0.0305	1.10005
147	regula-000	United States	Commercial	2048	1159	491	0.0308	1.10127
148	armatura-001	United States	Commercial	2048	756	270	0.0837	1.10139
149	via-001	Taiwan	Commercial	2048	1137	983	0.0415	1.10991
150	aware-006	United States	Commercial	352	1754	2598	0.0442	1.11006
151	bresee-002	China	Commercial	2048	1176	1778	0.0351	1.11675
152	xforwardai-001	China	Commercial	2048	1203	779	0.0303	1.11787
153	acisw-008	Thailand	Commercial	2048	336	1327	0.1067	1.11952
154	scanovate-002	Israel	Commercial	2048	1172	3021	0.0343	1.12054
155	hzailu-001	China	Commercial	2056	1159	894	0.0419	1.12096
156	sertis-002	Thailand	Commercial	2048	1221	1086	0.0304	1.1256
157	bioidtechswiss-001	Switzerland	Commercial	512	1793	2610	0.0345	1.1268
158	incode-010	United States	Commercial	2048	1221	1164	0.032	1.12782
159	innovativetechnologyltd-002	Great Britain	Commercial	2048	766	1841	0.0896	1.12849
160	yoornik-003	Portugal	Commercial	2048	983	684	0.0726	1.12972
161	mobbl-003	Spain	Commercial	2048	691	12506	0.0342	1.13531
162	yoornik-002	Portugal	Commercial	2048	1126	761	0.0574	1.13764
163	innefulabs-000	India	Commercial	2048	1135	5782	0.0384	1.139
164	regula-001	United States	Commercial	2048	1255	361	0.033	1.14117
165	seventhsense-000	Singapore	Commercial	2052	1272	1800	0.0304	1.14906
166	lemalabs-001	India	Commercial	2048	844	11930	0.0315	1.15378
167	geo-004	Taiwan	Commercial	2048	1296	1023	0.0308	1.1557
168	seventhsense-001	Singapore	Commercial	2052	1288	1936	0.0302	1.15574
169	realnetworks-005	United States	Commercial	2056	1312	1213	0.0322	1.16666
170	cloudwalk-mt-004	China	Commercial	2048	927	11744	0.0304	1.17059
171	synology-002	Taiwan	Commercial	2048	1317	1466	0.035	1.17078
172	hisign-001	China	Commercial	2080	1325	201	0.0311	1.176
173	tinkoff-001	Russia	Commercial	2048	1203	4361	0.0563	1.18215
174	ivacognitive-001	Russia	Commercial	2048	1321	4228	0.0338	1.18689
175	insightface-001	China	Commercial	2048	1386	1119	0.0301	1.19204
176	dahua-006	China	Commercial	2048	1402	249	0.0301	1.19755
177	insightface-002	China	Commercial	2048	1413	1169	0.0301	1.20349
178	clearviewai-000	United States	Commercial	2048	1418	1592	0.0297	1.20632

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Rank	Algorithm	Location	Commercial Academic	Template Size	Gen Time	Match Time	Accuracy (FNMR)	Performance (4D Magnitude)
179	intelresearch-004	Iceland	Academic	2048	1411	4696	0.0307	1.22393
180	toshiba-005	Japan	Commercial	2056	1459	1613	0.0306	1.22704
181	intelresearch-005	Iceland	Commercial	2048	1423	4524	0.0307	1.22736
182	pixelall-006	China	Commercial	2560	1054	754	0.0304	1.23071
183	toshiba-004	Japan	Commercial	2056	1479	1020	0.0304	1.23387
184	androvideo-000	Taiwan	Commercial	2048	620	2860	0.1255	1.25174
185	remarkai-001	China	Commercial	2052	1519	1229	0.0351	1.25623
186	vnpt-004	Viet Nam	Commercial	2048	1505	4047	0.0302	1.25756
187	deepglint-004	China	Commercial	2048	1492	5961	0.0304	1.27054
188	csc-003	United States	Commercial	544	535	393	0.1793	1.27583
189	csc-002	United States	Commercial	544	514	367	0.1802	1.27852
190	cloudwalk-mt-005	China	Commercial	2048	1229	12525	0.0305	1.28469
191	intellivision-003	United States	Commercial	2056	591	11069	0.1094	1.28926
192	intellivision-002	United States	Commercial	2056	600	13525	0.098	1.30514
193	aiunionface-000	Taiwan	Commercial	2048	1639	1072	0.0345	1.30724
194	papsav1923-002	Turkey	Commercial	2052	1641	1209	0.0337	1.3085
195	aize-001	Japan	Commercial	2048	1583	1937	0.053	1.31325
196	videmo-001	Germany	Commercial	2048	165	296	0.1516	1.32325
197	daon-000	Ireland	Commercial	2065	1055	16052	0.0358	1.33364
198	iit-002	Russia	Academic	2048	733	1023	0.1408	1.33853
199	notiontag-002	India	Commercial	2120	471	20278	0.0326	1.3626
200	ntechlab-012	Russia	Commercial	2560	1460	211	0.0302	1.37104
201	pxl-001	Switzerland	Commercial	512	1470	5598	0.1476	1.37683
202	kneron-005	United States	Commercial	2048	1760	1922	0.0517	1.38959
203	icthtc-000	China	Academic	2048	1719	5284	0.051	1.39101
204	tiger-006	United States	Commercial	2052	1848	1810	0.0319	1.40384
205	yuan-003	Taiwan	Commercial	2048	1878	2320	0.0424	1.4315
206	innovatrics-007	Slovakia	Commercial	1064	2210	5978	0.0308	1.43902
207	awiros-002	India	Commercial	2048	946	1966	0.1541	1.45159
208	irex-000	United States	Commercial	3080	1249	201	0.0313	1.46863
209	vocord-009	Russia	Commercial	1920	2064	2052	0.0304	1.47878
210	aware-005	United States	Commercial	1572	2195	1475	0.0429	1.49192
211	mobai-001	Norway	Commercial	2048	1707	1386	0.1069	1.50419
212	mobipintech-000	South Korea	Commercial	2048	1707	14506	0.0348	1.51565
213	enface-000	Russia	Commercial	1024	2349	7059	0.0316	1.52357
214	synesis-007	Russia	Commercial	3080	1423	684	0.0318	1.52528
215	enface-001	Russia	Commercial	1024	2416	6734	0.0312	1.55694
216	sqisoft-001	South Korea	Commercial	2056	1393	797	0.1519	1.56513
217	sktelecom-000	South Korea	Commercial	1536	1155	26583	0.0319	1.61836
218	f8-002	Taiwan	Commercial	2048	702	14765	0.1641	1.62048
219	sjtu-003	China	Academic	2048	2373	1560	0.0306	1.66101
220	smilart-003	Germany	Commercial	512	2299	1395	0.1381	1.68026
221	xm-000	China	Academic	2052	2434	1634	0.0306	1.69341
222	icm-003	Australia	Commercial	2048	1381	24351	0.0375	1.69363
223	verihubs-inteligensia-000	Indonesia	Commercial	2048	1621	22351	0.0314	1.69778

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Rank	Algorithm	Location	Commercial Academic	Template Size	Gen Time	Match Time	Accuracy (FNMR)	Performance (4D Magnitude)
224	20face-001	Netherlands	Commercial	4096	267	5553	0.0406	1.70845
225	suprema-001	South Korea	Commercial	2048	2443	3212	0.0405	1.71217
226	paravision-010	United States	Commercial	4100	635	1577	0.0303	1.71507
227	corsight-002	Israel	Commercial	2080	1388	24953	0.0302	1.71637
228	synesis-006	Russia	Commercial	4104	639	697	0.0322	1.71735
229	kakaopay-001	South Korea	Commercial	4096	553	633	0.0462	1.71811
230	paravision-008	United States	Commercial	4096	702	337	0.0301	1.72106
231	suprema-002	South Korea	Commercial	2048	2479	3255	0.0318	1.7225
232	yuan-004	Taiwan	Commercial	4096	607	5816	0.033	1.73412
233	camvi-002	United States	Commercial	1024	2785	612	0.032	1.73426
234	digitalbarriers-002	Great Britain	Commercial	2056	2236	13409	0.0574	1.75331
235	intellicloudai-002	China	Commercial	4100	878	822	0.0335	1.75461
236	kedacom-000	Singapore	Commercial	292	665	684	0.2529	1.76371
237	xforwardai-002	China	Commercial	4096	967	1406	0.0304	1.76815
238	closeli-001	China	Commercial	4096	865	5404	0.0347	1.77139
239	lookman-004	India	Commercial	548	656	871	0.2535	1.77657
240	remarkai-003	China	Commercial	4100	1019	787	0.0302	1.77905
241	sodec-000	Turkey	Commercial	4096	1061	1794	0.03	1.78796
242	kuke3d-001	China	Commercial	4096	834	6412	0.0483	1.78871
243	minivision-000	China	Commercial	4096	1059	2466	0.0299	1.78939
244	fujitsulab-003	China	Commercial	4104	1045	2855	0.0305	1.79128
245	allgovision-000	India	Commercial	2048	710	29903	0.0695	1.80246
246	intellifusion-002	China	Commercial	4096	1171	1713	0.0337	1.81526
247	aimall-003	China	Commercial	1024	807	34565	0.0335	1.82845
248	visteam-002	Portugal	Academic	4096	1013	6952	0.0556	1.83592
249	verigram-001	Kazakhstan	Commercial	2048	2733	1664	0.0299	1.84895
250	fiberhome-nanjing-004	China	Commercial	4096	1326	1276	0.0297	1.84919
251	fujitsulab-002	China	Commercial	4104	1327	2836	0.0316	1.85797
252	dahua-007	China	Commercial	4096	1379	367	0.03	1.86233
253	psl-010	Singapore	Commercial	4168	1396	354	0.0301	1.89282
254	visteam-003	Portugal	Academic	4096	1370	6816	0.0386	1.89694
255	uluface-002	China	Commercial	2048	2333	19207	0.0492	1.90912
256	verigram-000	Kazakhstan	Commercial	2048	2848	1222	0.03	1.90959
257	vnpt-003	Viet Nam	Commercial	4096	1428	7397	0.0315	1.91149
258	samsungsds-000	South Korea	Commercial	2048	343	23722	0.1895	1.93294
259	camvi-004	United States	Commercial	2048	2891	948	0.0318	1.93363
260	psl-009	Singapore	Commercial	4168	1385	316	0.0751	1.94655
261	megvii-005	China	Commercial	2049	1298	32025	0.0313	1.95311
262	alice-000	Spain	Commercial	4096	1264	14975	0.0332	1.97729
263	s1-003	South Korea	Commercial	4096	955	3657	0.139	1.99757
264	shu-003	China	Academic	2048	3045	2506	0.0309	2.0194
265	eocortex-000	Russia	Commercial	2048	513	923	0.2699	2.03153
266	omsecurity-000	South Korea	Commercial	1024	193	481	0.2956	2.04875
267	itmo-008	Russia	Academic	4096	1104	3578	0.152	2.0671
268	ytu-000	China	Commercial	2048	1949	31797	0.0313	2.13042

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Rank	Algorithm	Location	Commercial Academic	Template Size	Gen Time	Match Time	Accuracy (FNMR)	Performance (4D Magnitude)
269	toppanidgate-000	Taiwan	Commercial	4096	917	25262	0.04	2.15879
270	faceX-002	India	Commercial	2048	1738	631	0.256	2.1867
271	kasikornlabs-000	Thailand	Commercial	2048	2382	31669	0.0706	2.31886
272	luxand-000	United States	Commercial	1040	562	828	0.338	2.35318
273	adera-002	Singapore	Commercial	5120	1464	2163	0.1013	2.35349
274	adera-003	Singapore	Commercial	5120	1469	2148	0.101	2.35398
275	uluface-003	China	Commercial	3072	2469	26057	0.0663	2.36144
276	meituan-000	China	Commercial	2048	3126	638	0.1771	2.37481
277	kneron-003	United States	Commercial	2048	1224	5237	0.3097	2.3863
278	farfaces-001	United Kingdom	Commercial	512	1209	855	0.3368	2.40382
279	20face-000	Netherlands	Commercial	2048	224	44880	0.0723	2.4103
280	neosystems-003	Canada	Commercial	2048	2273	19130	0.2321	2.4291
281	sjtu-004	China	Academic	4608	2738	3057	0.03	2.49609
282	nsensecorp-003	South Korea	Commercial	2048	659	44658	0.1315	2.54039
283	cyberlink-008	Taiwan	Commercial	6212	760	263	0.03	2.56091
284	cyberlink-007	Taiwan	Commercial	6212	767	304	0.0301	2.56172
285	gorilla-007	Taiwan	Commercial	6288	722	3686	0.0311	2.59404
286	canon-004	Japan	Commercial	6200	1064	7172	0.0298	2.61854
287	canon-003	Japan	Commercial	6180	1482	4783	0.0302	2.67039
288	cloudmatrix-001	Taiwan	Commercial	2048	169	50263	0.096	2.6874
289	deepglint-003	China	Commercial	6144	1163	17227	0.03	2.72327
290	netbridgetech-001	Taiwan	Commercial	4096	113	9280	0.3255	2.79647
291	mobbl-001	Spain	Commercial	2048	2781	11832	0.2983	2.80888
292	cloudmatrix-000	Taiwan	Commercial	2048	793	49192	0.1577	2.81057
293	megvii-004	China	Commercial	4097	1436	46801	0.0311	2.97006
294	beyneai-000	Kazakhstan	Commercial	2048	4669	3730	0.0811	2.97626
295	aise-002	Japan	Commercial	2048	4617	597	0.1187	2.99945
296	synology-000	Taiwan	Commercial	2048	4568	19720	0.0373	3.03157
297	realnetworks-006	United States	Commercial	2056	774	469	0.4285	3.05572
298	nhn-003	South Korea	Commercial	4096	1375	50560	0.0311	3.10522
299	openface-001	South Korea	Commercial	2048	616	608	0.4433	3.13782
300	videonetics-002	India	Commercial	2052	3151	1219	0.3504	3.14622
301	samsungsds-001	South Korea	Commercial	4096	1514	51559	0.0302	3.16712
302	wicket-000	United States	Commercial	2048	1537	60976	0.0351	3.25167
303	mendaxiatech-000	China	Commercial	4097	2689	46906	0.0306	3.27134
304	oz-004	Russia	Commercial	2053	1608	61654	0.0356	3.29537
305	nhn-002	South Korea	Commercial	4096	1203	56608	0.0334	3.32499
306	ayfttech-001	China	Commercial	512	5412	615	0.1247	3.35964
307	biocube-001	India	Commercial	4096	1282	21787	0.3928	3.40069
308	gorilla-008	Taiwan	Commercial	8338	720	4530	0.0306	3.41255
309	pensees-001	Singapore	Commercial	8200	1546	3151	0.0315	3.45285
310	aigen-002	Thailand	Commercial	2048	5427	3678	0.1488	3.5104
311	aigen-001	Thailand	Commercial	2048	5691	3772	0.0831	3.56093
312	videonetics-001	India	Commercial	512	2393	1153	0.4804	3.56385
313	alfabeta-001	Indonesia	Commercial	512	2547	470	0.4872	3.64334

APPENDIX 4

NIST PERFORMANCE ON THE WILD IMAGE DATASET

Rank	Algorithm	Location	Commercial Academic	Template Size	Gen Time	Match Time	Accuracy (FNMR)	Performance (4D Magnitude)
314	boetech-001	China	Commercial	2048	318	68519	0.1778	3.67627
315	visionbox-001	Portugal	Commercial	2048	5955	1161	0.0448	3.67824
316	boetech-002	China	Commercial	2048	348	68921	0.1721	3.68294
317	iws-000	United States	Commercial	512	2987	999	0.4745	3.68651
318	aimall-002	China	Commercial	2048	1003	72811	0.0361	3.73014
319	mobai-000	Norway	Commercial	6144	3549	16458	0.2699	3.83389
320	asusaics-000	Taiwan	Commercial	2048	6305	5455	0.0332	3.88576
321	veridas-007	Spain	Commercial	2048	6374	655	0.0311	3.91619
322	griaule-000	United States	Commercial	2052	6406	3987	0.0367	3.94222
323	awiros-001	India	Commercial	512	556	1079	0.5826	3.96752
324	ekin-002	Turkey	Commercial	3072	1207	4294	0.5749	4.15769
325	oz-003	Russia	Commercial	2053	3209	73905	0.0319	4.19907
326	moreidian-000	China	Commercial	2048	713	1803	0.6087	4.22946
327	revealmedia-005	United Kingdom	Commercial	4100	442	2023	0.5745	4.24058
328	acisw-007	Thailand	Commercial	2048	484	1316	0.6372	4.40641
329	meituan-001	China	Commercial	2048	1011	654	0.6392	4.45127
330	neosystems-002	Canada	Commercial	2048	2247	18752	0.6056	4.49327
331	cybercore-001	Japan	Commercial	2048	502	52119	0.5301	4.49895
332	asusaics-001	Taiwan	Commercial	4096	7284	8618	0.0332	4.69536
333	dicio-001	Mexico	Commercial	520	5286	2818	0.5209	4.75042
334	veridas-006	Spain	Commercial	2048	6414	56940	0.032	4.83261
335	turingtechvip-001	China	Commercial	2048	1476	1733	0.7044	4.92524
336	nsensecorp-002	South Korea	Commercial	2048	351	45965	0.6702	5.14365
337	euronovate-001	Switzerland	Commercial	1177	1172	81294	0.4986	5.30089
338	cybercore-002	Japan	Commercial	2048	528	12389	0.7708	5.33254
339	lebentech-000	Mexico	Commercial	512	23	801	0.7965	5.40123
340	glory-003	Japan	Commercial	4234	8941	6020	0.0806	5.66172
341	antheus-000	Brazil	Commercial	520	236	6901	0.8467	5.75285
342	glory-004	Japan	Commercial	4182	9360	4982	0.0796	5.89111
343	antheus-001	Brazil	Commercial	520	2660	6218	0.8476	5.97221
344	dps-000	France	Commercial	4096	9345	1473	0.2172	6.02564
345	graymatics-001	United States	Commercial	4096	7150	39874	0.5041	6.05223
346	ailabs-001	Taiwan	Commercial	2048	5205	104034	0.0394	6.05324
347	smartengines-000	Russia	Commercial	288	275	197	0.9011	6.10921
348	vt-000	Viet Nam	Commercial	2048	517	124209	0.063	6.18331
349	unissey-001	France	Commercial	4096	10017	1463	0.1521	6.31521
350	techsign-000	Turkey	Commercial	2048	10460	4758	0.0749	6.35063
351	facetag-000	South Korea	Commercial	684	7930	72003	0.3566	6.4067
352	intsysmsu-001	Russia	Academic	2048	1159	621	0.9547	6.55884
353	tuputech-000	China	Commercial	2048	411	23893	0.9549	6.63263
354	dsk-000	China	Commercial	512	10451	7152	0.3333	6.67322
355	cloudwalk-hr-004	China	Commercial	2049	902	11652	0.9717	6.68276
356	id3-008	France	Commercial	264	1433	5658	0.9806	6.7065
357	vinbigdata-001	Viet Nam	Commercial	2048	1404	1351	0.9771	6.72565
358	surrey-cvssp-000	United Kingdom	Academic	2048	1245	9557	0.9833	6.7718

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NIST PERFORMANCE ON THE WILD IMAGE DATASET

Rank	Algorithm	Location	Commercial Academic	Template Size	Gen Time	Match Time	Accuracy (FNMR)	Performance (4D Magnitude)
359	coretech-000	Taiwan	Commercial	512	1165	333	1	6.81509
360	id3-006	France	Commercial	520	1270	5547	0.9986	6.81794
361	securifai-003	Romania	Commercial	4104	546	1714	0.977	6.83334
362	ctbcbank-000	Taiwan	Commercial	2048	831	3551	1	6.84681
363	cudocommunication-001	South Korea	Commercial	2048	964	2534	1	6.85199
364	ctbcbank-001	Taiwan	Commercial	2048	1030	3926	1	6.85702
365	facex-001	India	Commercial	2048	1670	1871	1	6.90008
366	bresee-001	China	Commercial	2048	1360	37240	1	7.11444
367	chosun-001	South Korea	Academic	2048	11694	998	0.8264	9.01139
368	corsight-001	Israel	Commercial	2064	1379	249340	0.0301	12.31289
369	veridium-000	United Kingdom	Commercial	29399	111	64880	0.5452	12.8503
370	cor-001	Israel	Commercial	2060	952	270145	0.0307	13.31755
371	sukshi-000	India	Commercial	32768	1574	9817	0.82	14.40653
372	iqface-003	China	Commercial	4763	1694	575924	0.0423	28.39163
373	iqface-000	China	Commercial	4750	1393	636433	0.0423	31.35192
374	chosun-002	South Korea	Academic	2048	80302	623	0.0863	48.15783
375	shu-002	China	Academic	4096	3489	2930763	0.0324	144.07138

Although there are currently 416 algorithms in the NIST report, NIST did not report some metrics for all of them. If a submission was missing resource or accuracy data, it was not possible to determine system performance and therefor the submission was omitted from the Mugshot images chart.