Face Recognition Vendor Test
Part 7: Face Identification for Paperless Travel

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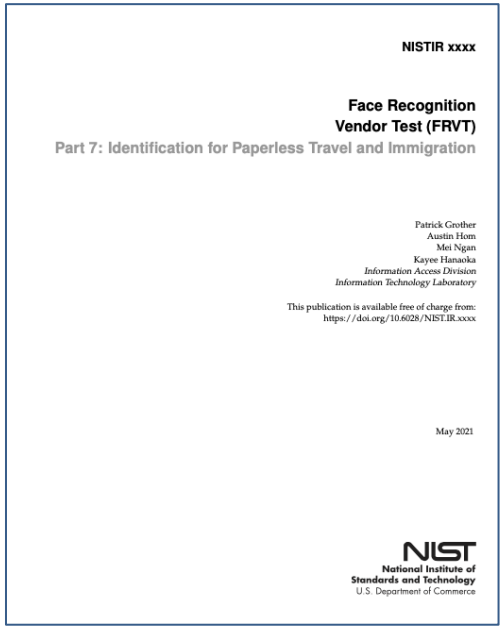
ICAO TRIP

May 26, 2021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Face Recognition
Vendor Test (FRVT)
Part 7: Identification for Paperless Travel and Immigration

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ONGOING BENCHMARKS

1. FRVT 1:1 Verification

2. FRVT 1:N Search Performance

3. FRVT Morph Morphed Photo Detection

4. FRVT Quality Automated Quality Assessment

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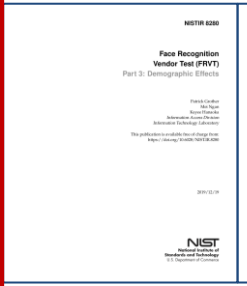
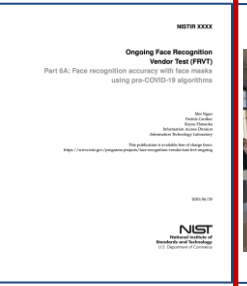
CURRENT PRODUCTS

UPCOMING

Part 1: Performance of 1:1 Verification Algorithms	Part 2: Performance of 1:N Identification Algorithms	Part 3: Demographic Effects in Face Recognition	Part 4: Performance of Morph Detection Algorithms	Part 5: Performance of Image Quality Assessment Algorithms	Part 6: Performance of Face Recognition with Face Masks	Part 7: Use of Face Recognition in Paperless Travel	Part 8: Performance of Face Recognition on Twins
							
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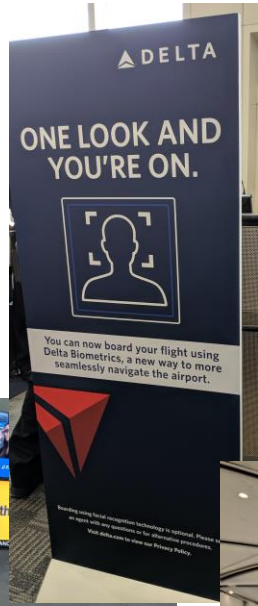
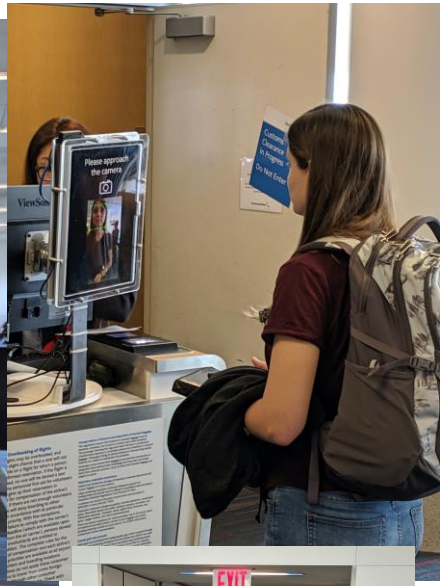
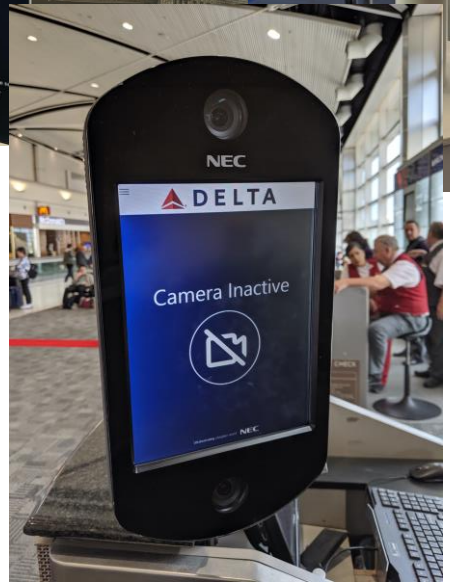
	A					B	

Positive Access Control
+ Immigration EXIT facilitation

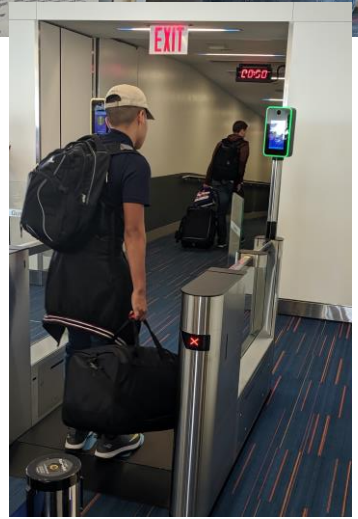
Via 1:N Paperless Boarding



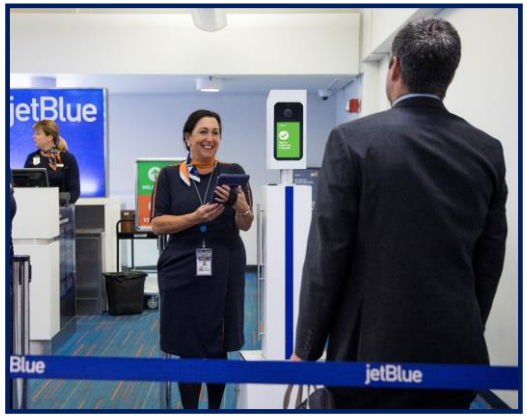




Diverse hardware, common matcher (TVS)



US/DHS's Immigration Exit Solution



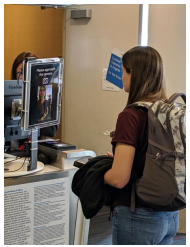
- Cameras: At least 6 developer implementations
- Population:
  - Those expected on flight per airline provided flight manifest.
  - US citizens included
- Biometric:
  - Face images from all known prior encounters of subject
  - For USCs, prior passport images.
- Search live face against database
  - Hundreds of people
  - Thousands of images
- TVS: Cloud-based recognizer
  - NEC algorithm. Version?
  - Image sent over high-speed low latency network. Round-trip transaction ~ 1 second.

- Airline, airport, government partnership
- Application
  - Facilitation of traveler's recording their exit for DHS
  - AND physical access control to aircraft for airlines
- Errors and resolution
  - False negative: Revert to traditional paper-based boarding process
  - False positive: Traveler boards plane; may be detected when actual traveler subsequently boards plane.

Paperless travel: “Touchpoints”

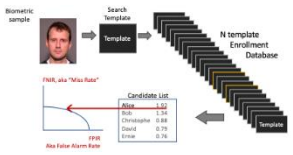
#	Which border	Step	1:1 Verification or 1:N Identification	Where	Enrolled database	False Neg Consequence
1	AIR	Initial verification against document	1:1 against passport or driving license	Check-in Automated bag drop	None	Retry, inconvenience
2	AIR	Is passenger allowed airside?	1:N	TSA Screening checkpoint	N ~ 10^5	Revert to manual process, inconvenience
3	AIR	Duty free shopping	1:N	Air-side shops	N ~ 10^5	Retry, inconvenience
4	AIR	Lounge access	1:N	Airline lounges	N ~ 10^4	Revert to manual process, pique!
5	AIR	Record immigration exit	1:N	At boarding gate	N < 500	Lack of biometric EXIT confirmation

Kinds of Tests of ENTRY-EXIT performance



Operational Tests — ISO/IEC 19794-6
- Logging of system
- Clipboard observation of actual aircraft boarding

→ ”Acid Test”: Gives actual performance on actual populations.



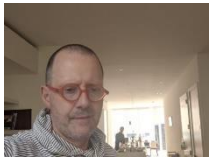
Offline Tests — ISO/IEC 19794-2
- Matching of captured images
- Run multiple algorithms

→ ”Replay” approximates reality. Scales well but doesn’t easily capture transactions, human roles, failures to capture, response times, user satisfaction

Scenario Tests — ISO/IEC 19794-2
- Human trials in a similar simulated env.
- Compare cameras / systems

→ Best of both worlds: Control population, measure human-camera-matcher interaction effects including time. Pop. and env. approximates the actual.

Paperless travel: EXIT simulations



826k AIR-ENTRY images, 2010... 2019

Same people

133k EXIT images, 2018-2019

Experiment #1
Generate 567 simulated flights

- **Enroll:**
  - N = 420 people
  - From the same region e.g. E. Asia
  - K = 1 AIR-ENTRY image per person
- **Search:**
  - Fixed 133K EXIT images
  - ~420 people in the gallery ⟶ FNIR
  - Most not ⟶ FPIR

Experiment #2

- Use K > 1 AIR-ENTRY image per person in gallery
- Everything else same

Experiment #3

- Use N = 42000 people in gallery
- K = 1 image each

Number of simulated flights (out of 567) with zero travelers rejected

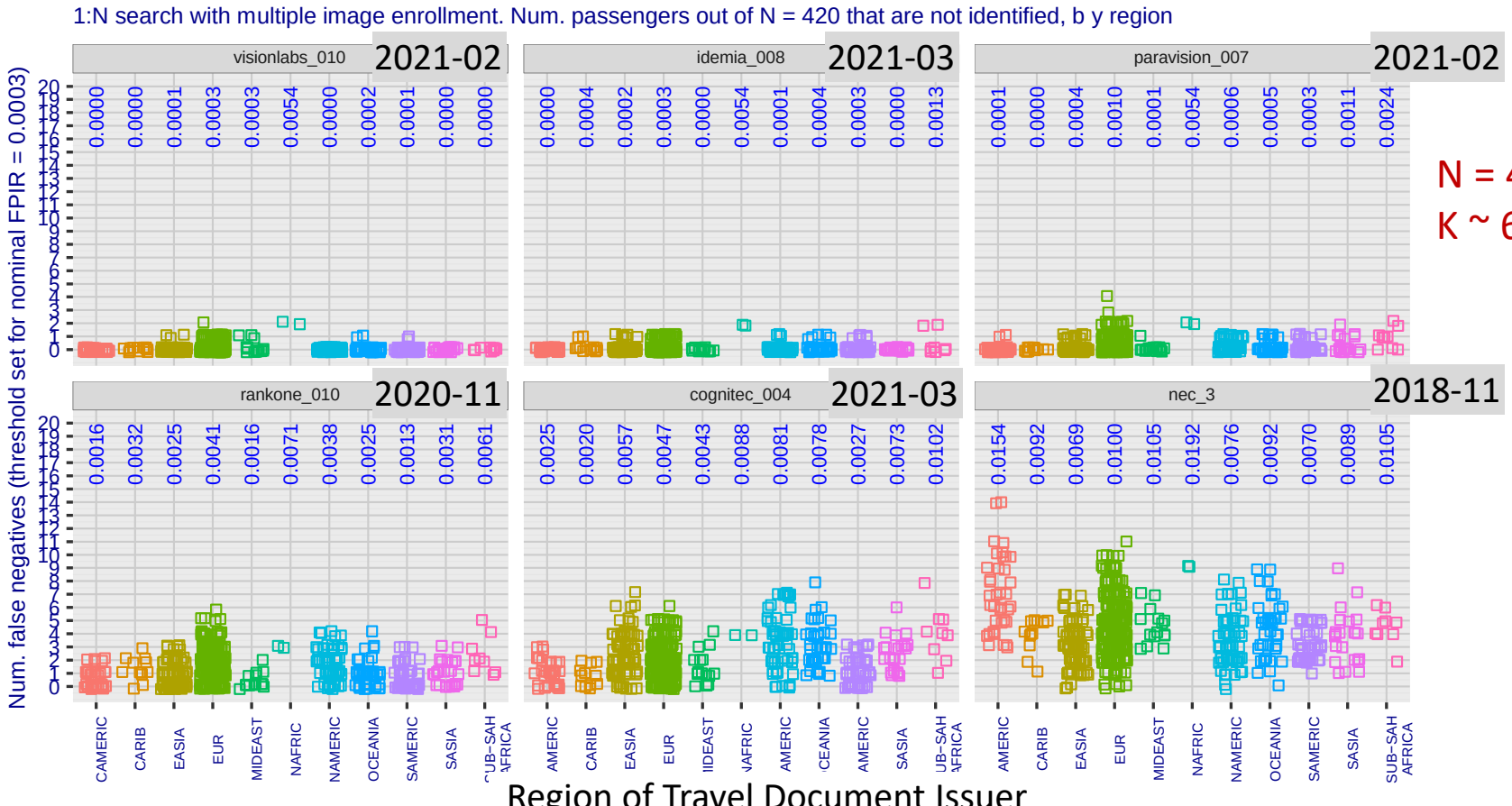
- Estimated over 567 simulated flights
- N = 420 people with
  - EITHER single image enrolled
  - OR multiple images enrolled

- Notable results:
  - NEC-3 boards 66 flights without error
  - Idemia boards 422 flights without error
  - ~20 algorithms better than NEC 2018

  - Accuracy better with multiple images
  - Single image is a lower bound on accuracy

ALGORITHM			$N = 420$	$N = 420$	
#	NAME	DATE	$k \geq 1$	$k = 1$	
1	CANON-CIB-000	2020-10-19	518	307	
2	CLOUDWALK-HR-000	2021-02-10	528	393	
3	COGENT-004	2021-02-10	454	182	
4	COGNITEC-004	2021-03-08	201	11	
5	DEEPGLINT-001	2020-07-23	519	336	
6	DERMALOG-007	2020-02-12	30	3	
7	DERMALOG-008	2021-01-25	382	71	
8	IDEMIA-004	2018-06-30	3	0	
9	IDEMIA-007	2020-01-17	374	66	
10	IDEMIA-008	2021-03-15	536	422	A
11	MICROSOFT-006	2018-10-29	361	155	
12	NEC-000	2018-06-21	0	0	
13	NEC-002	2018-10-30	111	65	
14	NEC-003	2018-10-30	111	66	B
15	NEUROTECHNOLOGY-007	2019-10-03	90	21	
16	NEUROTECHNOLOGY-008	2021-03-26	470	169	
17	NTECHLAB-008	2020-01-06	451	125	
18	PARAVISION-005	2019-12-11	453	156	
19	PARAVISION-007	2021-02-01	490	237	
20	PIXELALL-004	2020-07-02	435	146	
21	RANKONE-009	2020-06-26	203	38	
22	RANKONE-010	2020-11-05	300	76	
23	SENSETIME-004	2020-08-10	316	208	
24	SENSETIME-005	2020-12-17	319	233	
25	TECH5-002	2021-04-07	416	110	
26	TRUEFACE-000	2021-01-27	476	154	
27	VISIONLABS-009	2020-08-04	533	406	
28	VISIONLABS-010	2021-02-05	545	428	C
29	XFORWARDAI-001	2021-01-21	513	309	

EXIT Search Accuracy by Region and Algorithm



Simulated vs. actual estimates of current DHS EXIT accuracy

- We don't capture transactions e.g. where subject makes multiple attempts or is diverted to airline staff with old biographic process.
  - Airlines have incentives differ from DHS intent
- We don't have the TVS algorithm
  - NIST ran NEC prototypes from 2018 that are different to products shipped to DHS/CBP/TVS
- No passport images, neither USCs nor in-scope. We faked it with CBP air-entry instead.
  - Accuracy with passports would be better
- We don't have photos of young (< 12 years) children
  - Expect higher FNIR in rapidly ageing kids.

- Real images, yes, but the galleries are not galleries that existed in TVS; we simulated flights.
- Our galleries were constructed to hold people from one travel region (per their travel doc).
  - We expected accuracy estimates to be low due to in-gallery false positives relative to case of galleries composed of a more mixed population.
- No camera information; we used a pool of EXIT images from multiple cameras.
  - Accuracy will vary by camera because they vary in capture speed vs. quality, some move up-down, plus environmental differences
  - Cameras may have improved

THANKS

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