

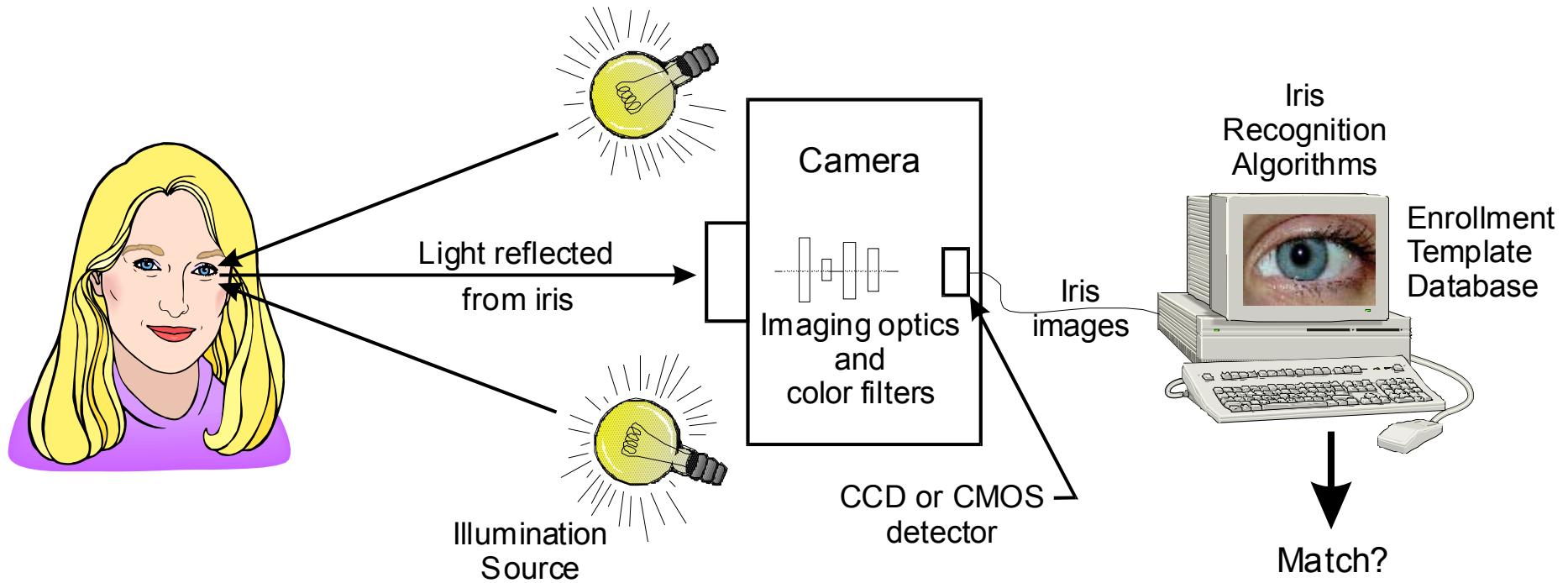


Iris Recognition Interoperability and Image Quality

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Biometrics Working Group
Working Session 38
13 July 2007
National Physical Laboratory

Iris Recognition Schematic



Interoperability and Image Quality Data Analysis

- Objective
 - Study the influence of iris image quality on the interoperability of iris recognition cameras and algorithms
 - Preliminary results
- Used iris images collected using three commercial iris recognition cameras
 - From NIJ/DHS Iris Recognition Study 2006 (IRIS06)
 - Camera names not identified
- Analysis performed for three different iris recognition algorithms
 - Algorithms not identified
- Used iris image quality metric output by Algorithm 1
 - Image quality metrics not available for other algorithms

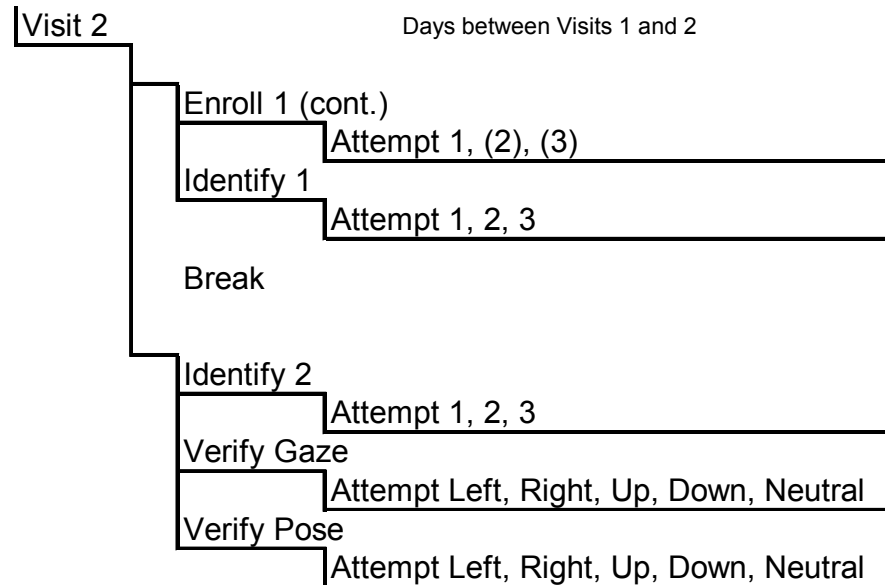
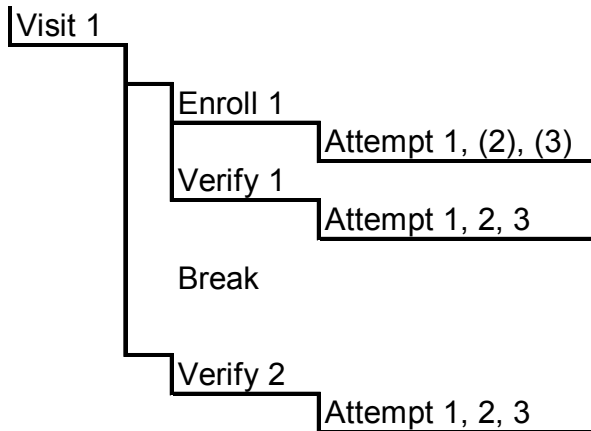
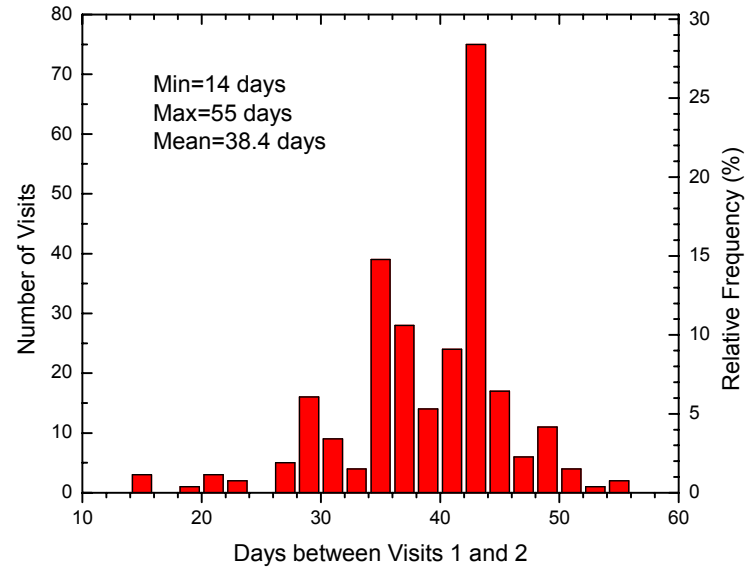
IRIS06 Objectives

- Evaluate the native and interoperability (inter-product) performance of commercial biometric iris recognition products using:
 - Iris image data interchange format standard (ISO/IEC 19794-6)
 - Biometric Application Programming Interface standard (ANSI INCITS 358-2002, BioAPI 1.1)
 - Biometric performance testing and reporting standard (ISO/IEC 19795)
- Investigate the sensitivity of biometric iris recognition technology to test subject presentation parameters, such as pose and eye-gaze angles

IRIS06 Overview

- Three commercial iris recognition products studied
 - Product names not identified
 - Vendors may choose to self-identify
- Data collected in standard indoor office environment using BioAPI 1.1 test harness interface
- About 29,000 ISO/IEC 19794-6 compliant iris images collected from ~300 live test subjects with demographics representative of the US population
- Two visits separated by ~6 weeks
 - Visit 1
 - 297 live human test subjects
 - Enroll, Verify 1, Verify 2
 - Visit 2
 - 264 repeat test subjects
 - Identify 1, Identify 2, Pose/Gaze experiments

Data Collected in Phoenix, Arizona



Test Subject Demographics

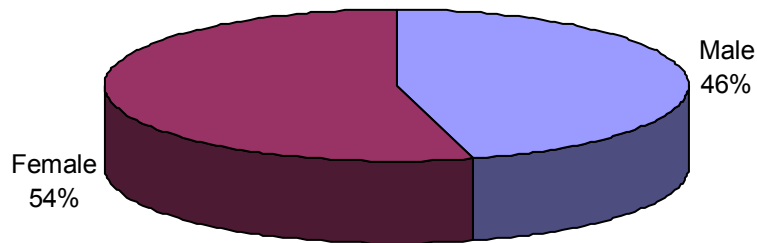
- Target demographic profile based on 2000 US Census

Test Subject Demographic Profile and Statistics									
	Visit 1				Visit 2				
	Target		Actual		Target		Actual		
# of Test Subjects	300		295		250		264		
# of Appointments	401		295		295		264		
No-Show Rate	26%				11%				
Collection Dates	5/1/06-6/10/06				6/12/06-7/15/06				
Male	147	49%	139	47%	123	49%	121	46%	
Female	153	51%	156	53%	128	51%	143	54%	
18-24	30	10%	29	10%	25	10%	22	8%	
25-34	60	20%	54	18%	50	20%	45	17%	
35-44	66	22%	69	23%	55	22%	64	24%	
45-54	57	19%	58	20%	48	19%	52	20%	
55-64	36	12%	38	13%	30	12%	36	14%	
65-74	27	9%	24	8%	23	9%	24	9%	
75+	24	8%	23	8%	20	8%	21	8%	
White	225	75%	220	75%	188	75%	199	75%	
Black/ African-American	36	12%	37	13%	30	12%	33	13%	
Asian	12	4%	10	3%	10	4%	7	3%	
Native American	3	1%	4	1%	3	1%	3	1%	
Others	24	8%	24	8%	20	8%	22	8%	
Hispanic	39	13%	35	12%	33	13%	33	13%	
Non-Hispanic	261	87%	260	88%	218	87%	231	88%	

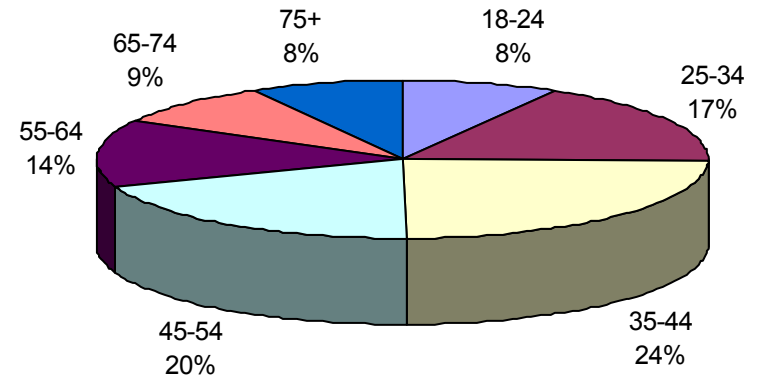
Visit 2 Demographics Pie Charts

(264 test subjects completed both Visits 1 and 2)

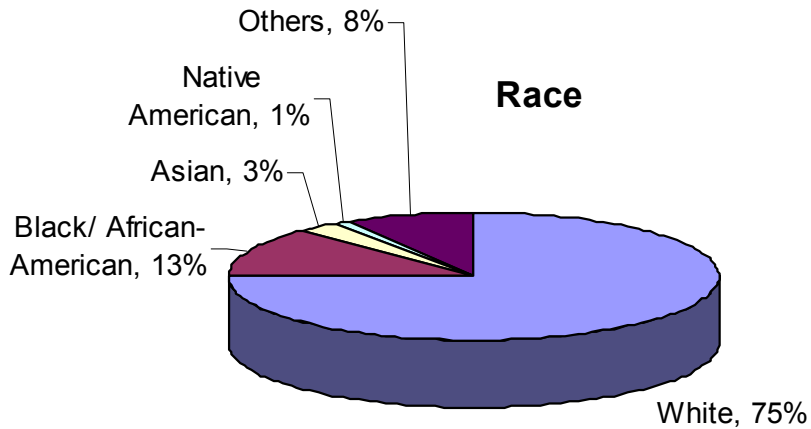
Gender



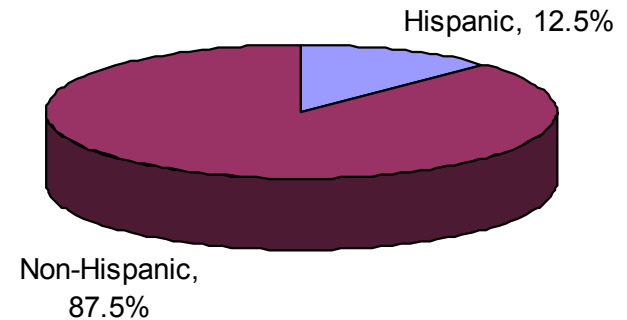
Age



Race



Heritage



IRIS06 Analysis

- Measured online, offline, and off-axis performance
 - Online analysis
 - FTE, FTA, FNMR, GFRR, enrollment transaction time, recognition transaction time
 - Offline analysis
 - TMR, FRM, GTAR, GFAR, ROCs
 - Algorithms provided by Professor John Daugman, University of Cambridge
(<http://www.cl.cam.ac.uk/users/jgd1000/>)
 - Confidence intervals
 - Uncorrelated comparison samples → adjusted Wald method
 - Correlated comparison samples → Logit Beta-binomial
 - Technical advice from Dr. Michael Schuckers
(<http://it.stlawu.edu/~msch/biometrics/>)

IRIS06 Draft Final Report

- Detailed draft final report (168 pages) and comments template available at <http://www.authenti-corp.com/iris06/report/>
 - Report available free of charge
 - Available in Microsoft Word and PDF formats
 - Salient results summarized in three-page executive summary
 - Public review cycle ends 31 July 2007
 - Funding and oversight provided by US Department of Justice, National Institute of Justice and the US Department of Homeland Security, Transportation Security Administration
 - Award No. 2005-IJ-CX-K066
 - The opinions, findings, conclusions, and recommendations expressed in this report are those of Authenti-Corp and do not necessarily reflect the views of the Department of Justice or the Department of Homeland Security

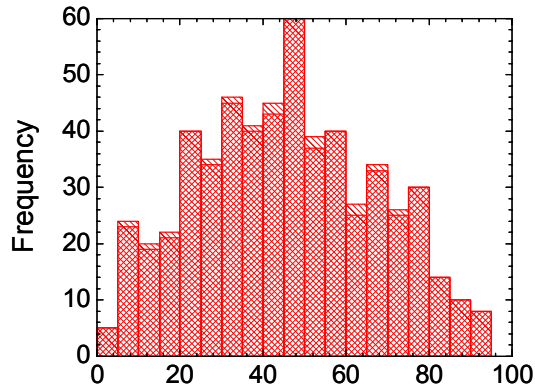
Data Analysis Details

Test Subject and Image Information

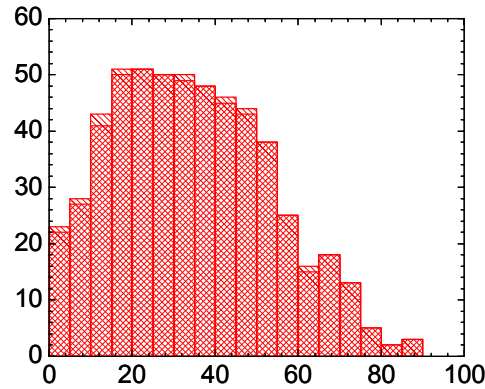
	Self Reported	Confirmed during review	Assigned during review	Measured during data collection	Filterable
Demographics					
Gender	✓				✓
Race	✓				✓
Ethnicity (Hispanic/Latino)	✓				✓
Age	✓				✓
Eye color	✓		✓		✓
Height	✓				
Standing eye height				✓	
Occupation	✓				
Image Parameters (Hints)					
Bad picture			✓		✓
Bad features			✓		✓
Obstruction			✓		✓
Bad placement			✓		✓
Bad environment			✓		✓
Features / Conditions					
Left eye / Right eye		✓			✓
Glasses	✓	✓			✓
Contacts	✓				✓
Hard Contacts		✓			✓
Eye conditions: amblyopia (lazy eye), acrus senilis, blepharoptosis (droopy eyelid), blindness, cataracts, detached retina, glass eye, glaucoma, macular degeneration, pink eye, recent trauma, strabismus, surgery (radial keratotomy, cataract, lasix, corneal replacement, other), unreactive pupil, other	✓				

- Manual data review time consuming but important
- Genuine scores from all recognition attempts included in analysis
 - Represents average performance over Visits 1 and 2
- Left and right eyes treated as separate individuals
 - Represents average performance of left and right eyes

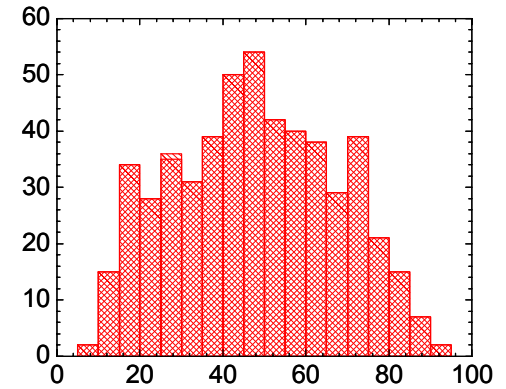
Camera A



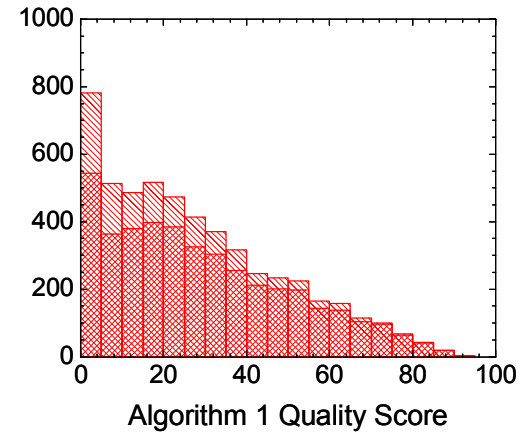
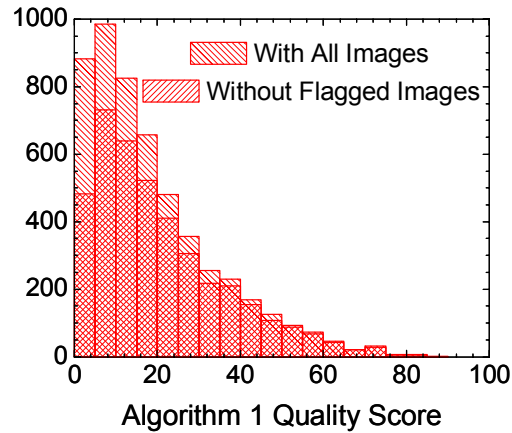
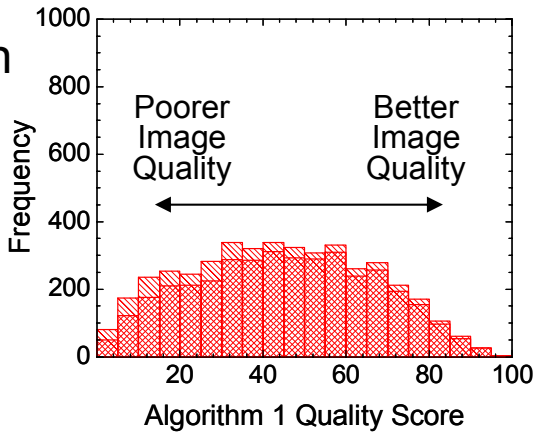
Camera B



Camera C

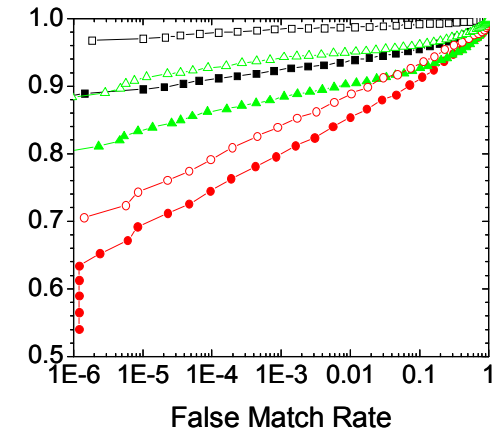
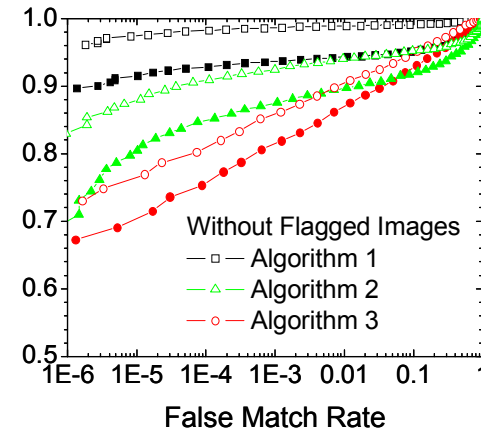
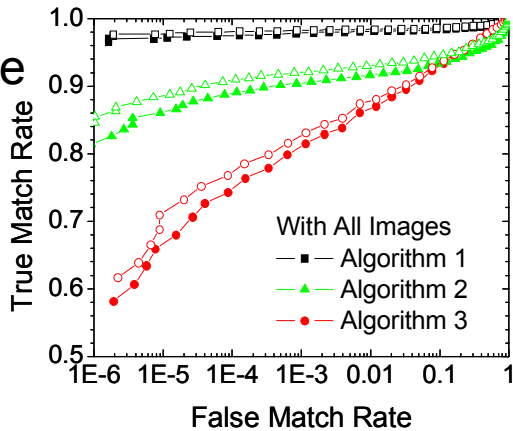


Enrollment
Image
Quality

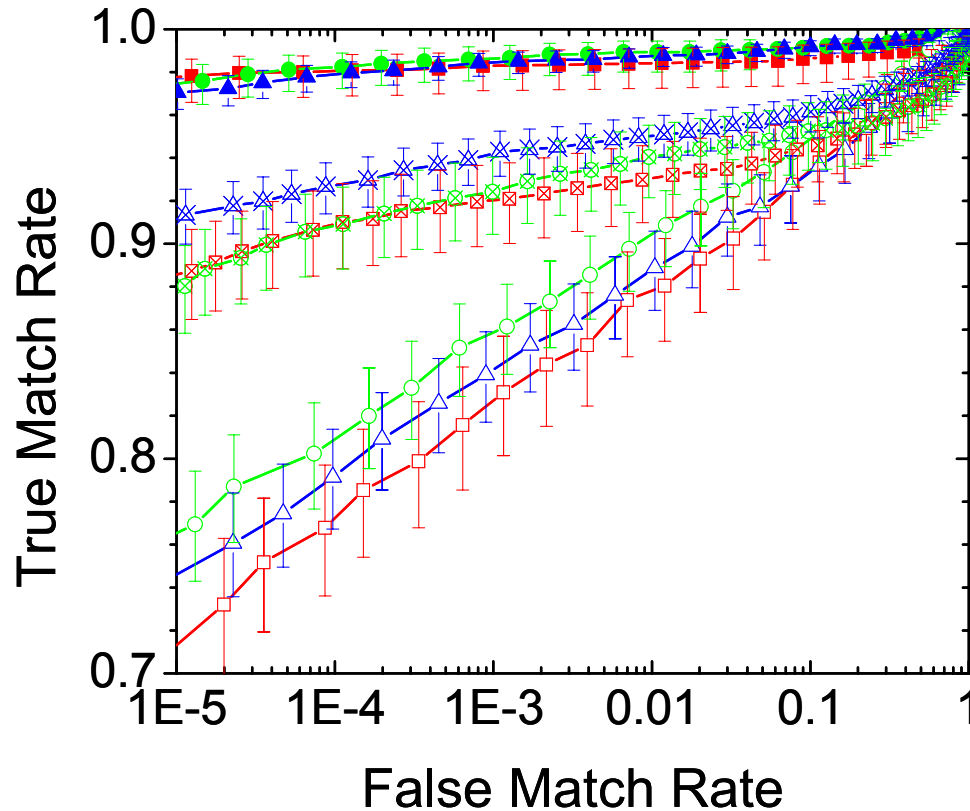


Recognition
Image
Quality

Matching
Performance

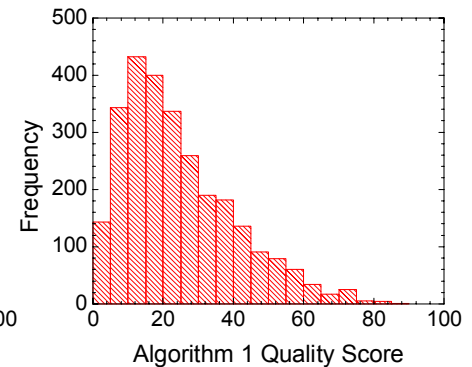
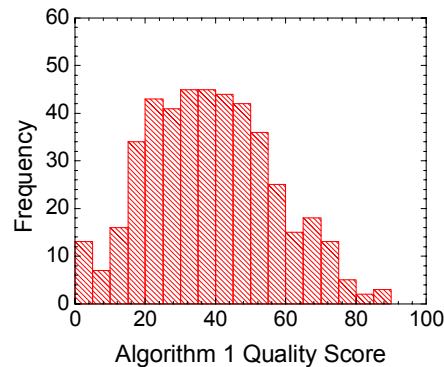
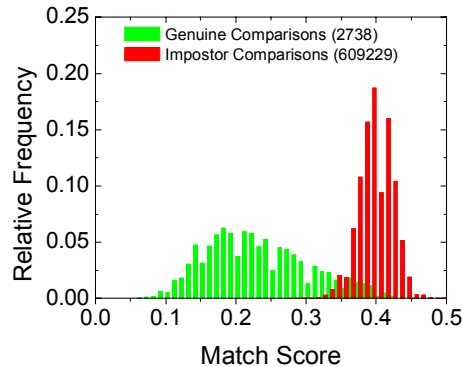
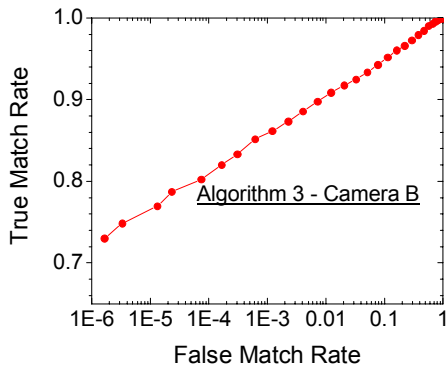
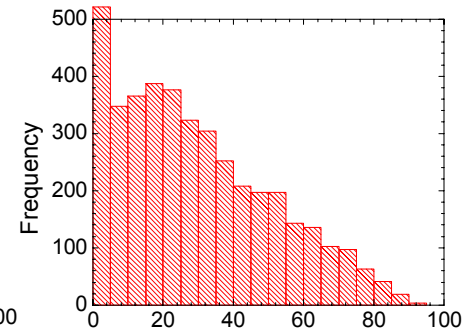
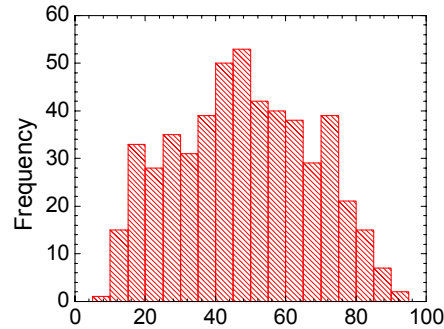
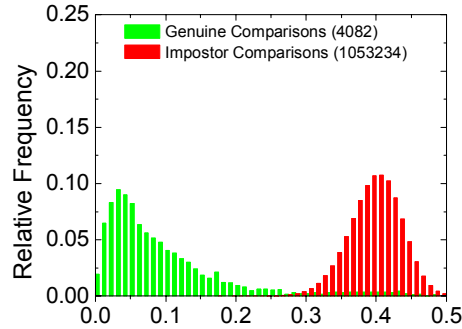
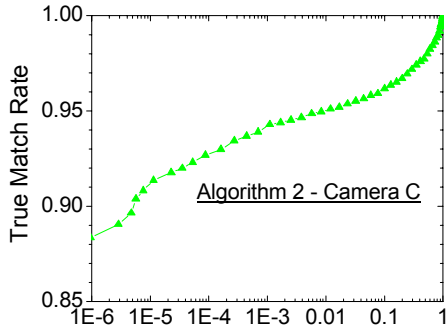
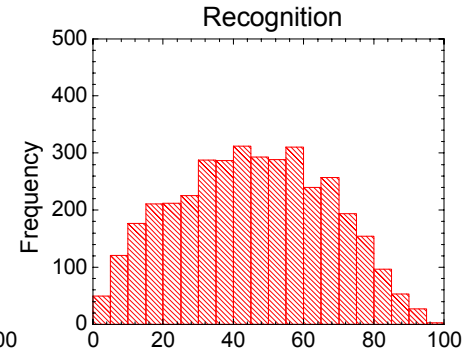
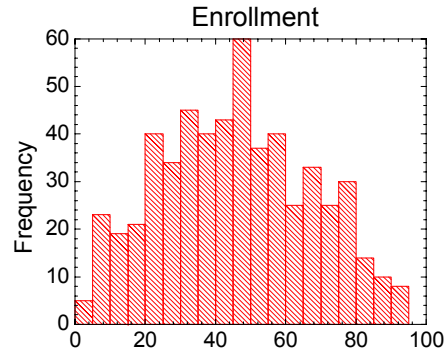
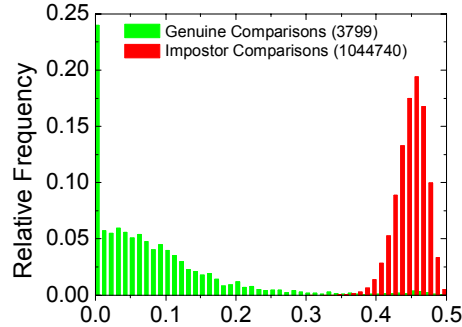
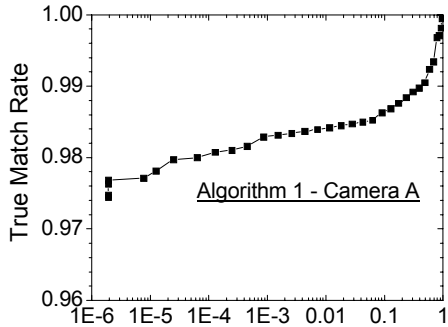


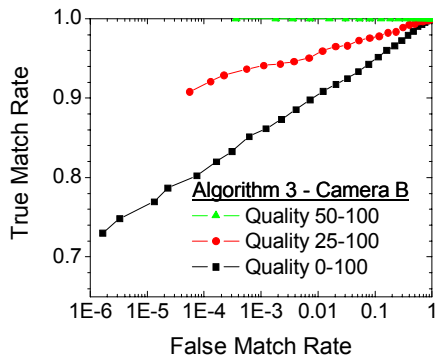
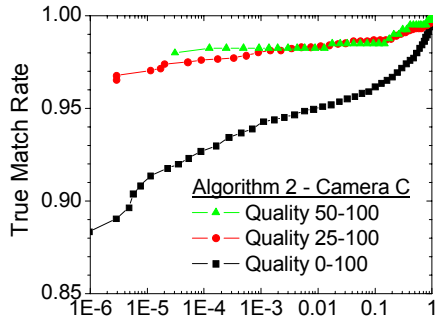
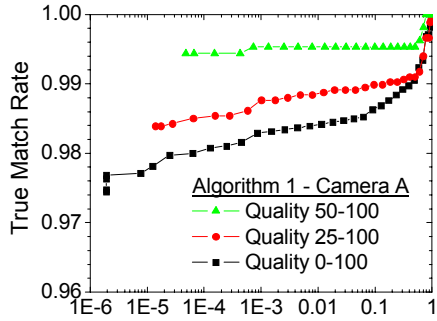
Native Performance Without Flagged Images



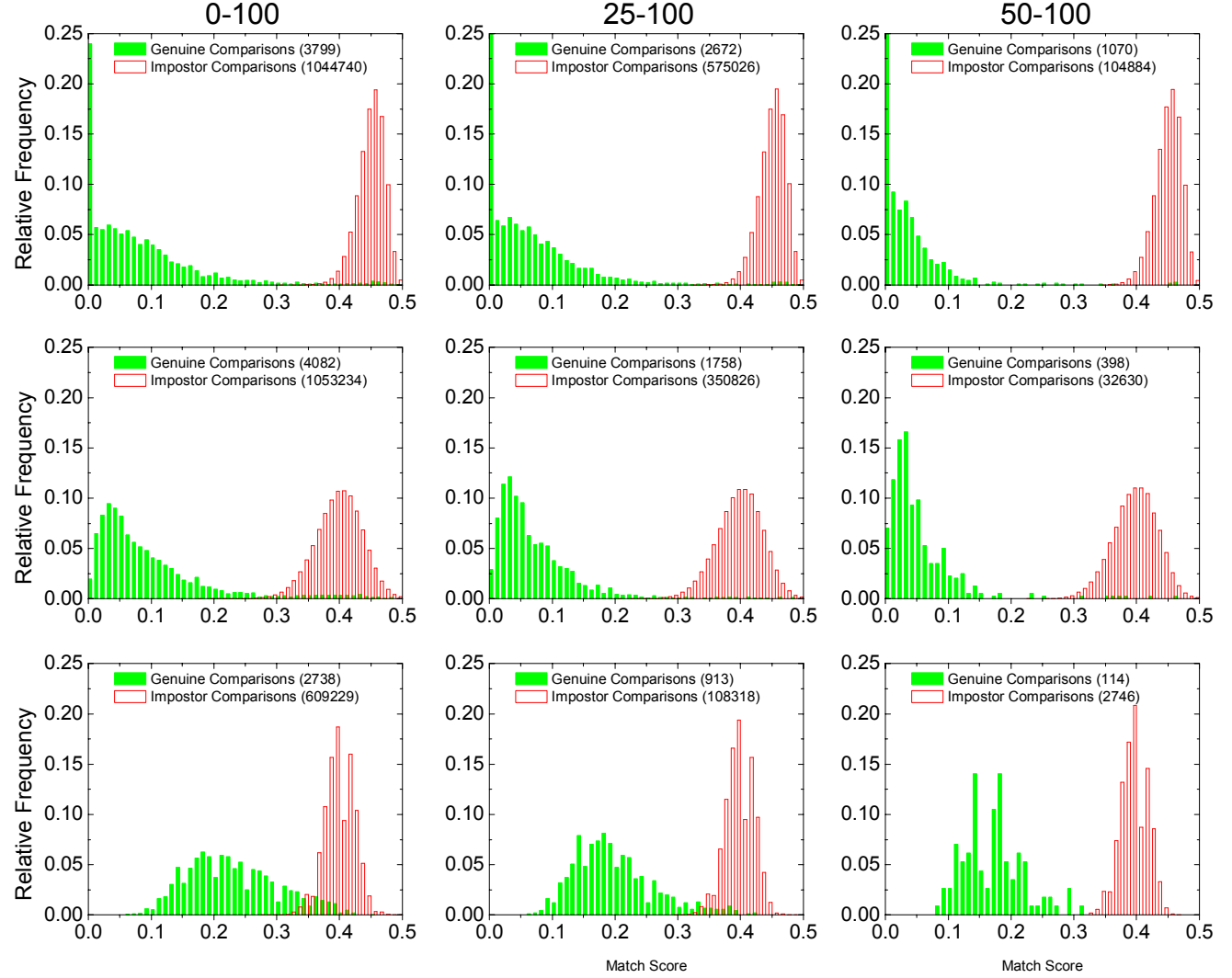
Alg 1 Alg 2 Alg 3
Product A —■— —⊠— —□—
Product B —●— —⊠— —○—
Product C —▲— —⊠— —△—

Remainder of analysis
excludes flagged images

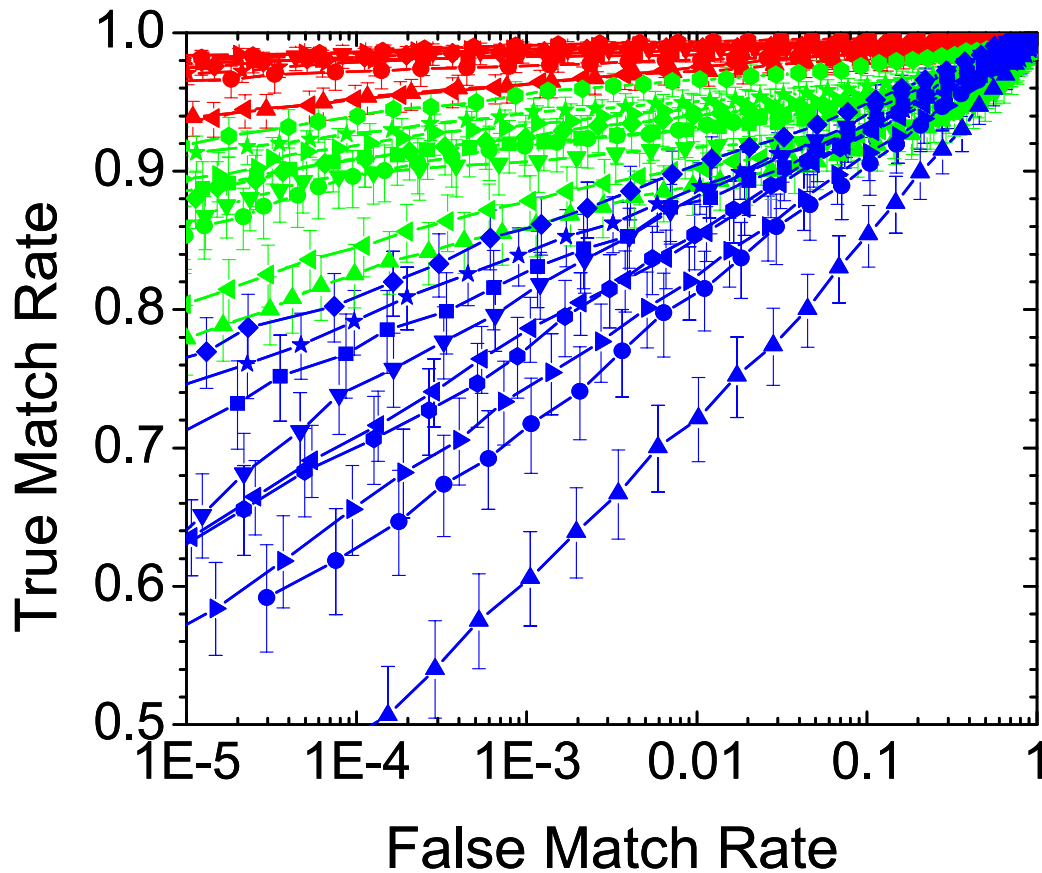




Algorithm 1 Quality Score



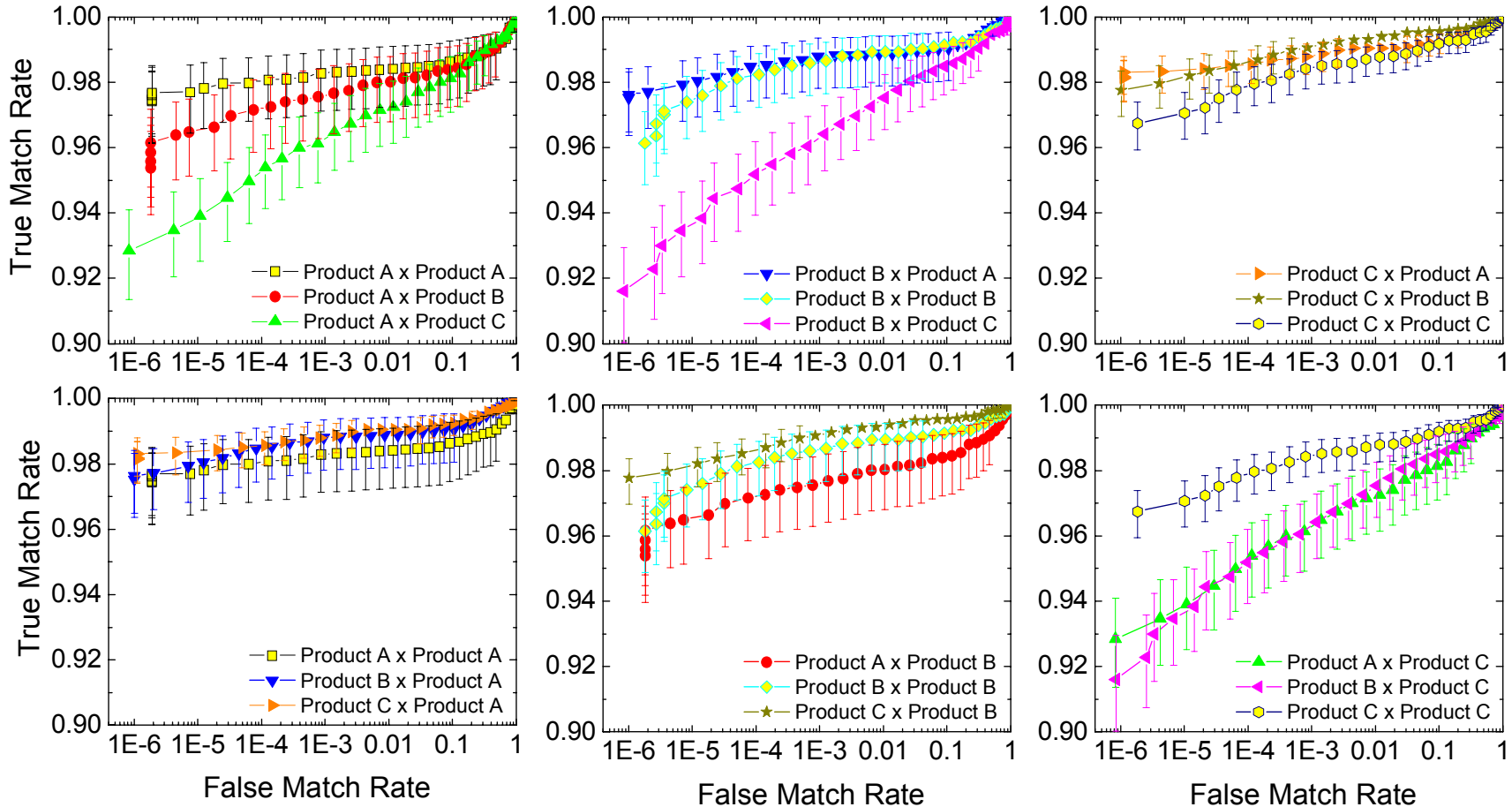
Interoperability Performance



	<u>Alg 1</u>	<u>Alg 2</u>	<u>Alg 3</u>
AxA	—■—	—■—	—■—
AxB	—●—	—●—	—●—
AxC	—▲—	—▲—	—▲—
BxA	—▼—	—▼—	—▼—
BxB	—◆—	—◆—	—◆—
BxC	—◀—	—◀—	—◀—
CxA	—▶—	—▶—	—▶—
CxB	—●—	—●—	—●—
CxC	—★—	—★—	—★—

Enrollment X Recognition
Camera Camera

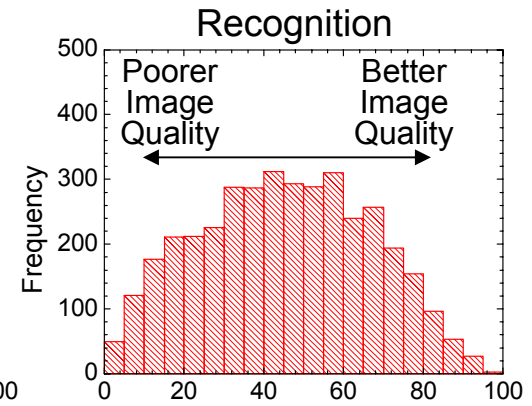
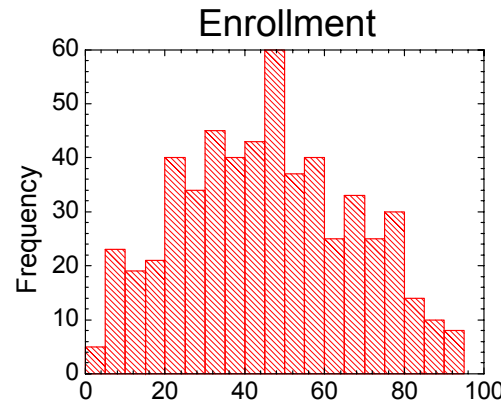
Interoperability Performance for Algorithm 1



- Camera C enrollment images exhibit best matching performance
- Camera A recognition images exhibit best matching performance
- Interoperable performance better than native performance in some cases!

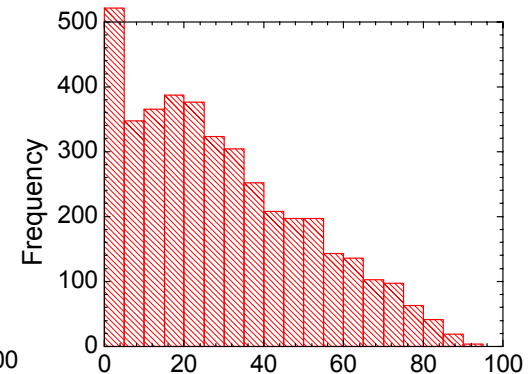
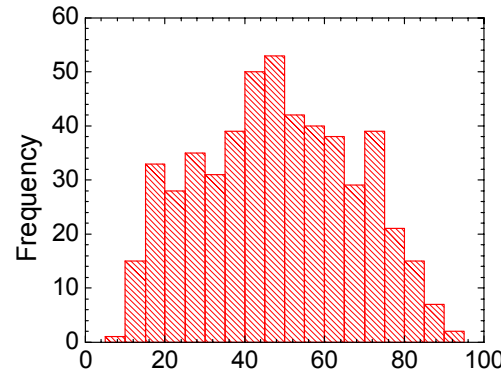
Camera A

- Best “Recognition” image quality distribution

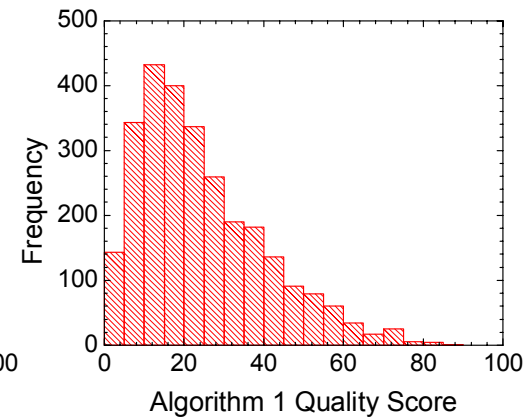
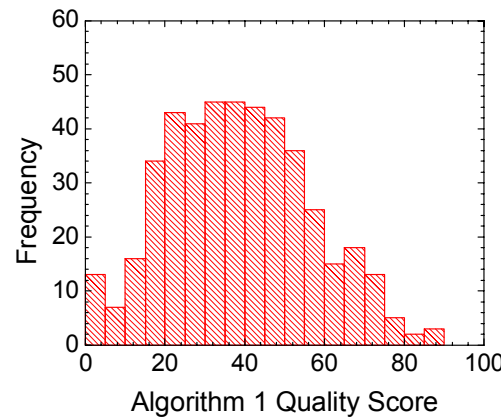


Camera C

- Best “Enrollment” image quality distribution



Camera B





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