Cross-Sensor Fingerprint Matching: Phone Camera v. Slap Capture

A. K. Jain, D. Deb, K. Cao, T. Chugh, J. Engelsma
Michigan State University, East Lansing

N. Nain, P. K. Chandaliya, S. Lamba, M. Singh, N. Chaudhary
Malaviya National Institute of Technology, Jaipur, India

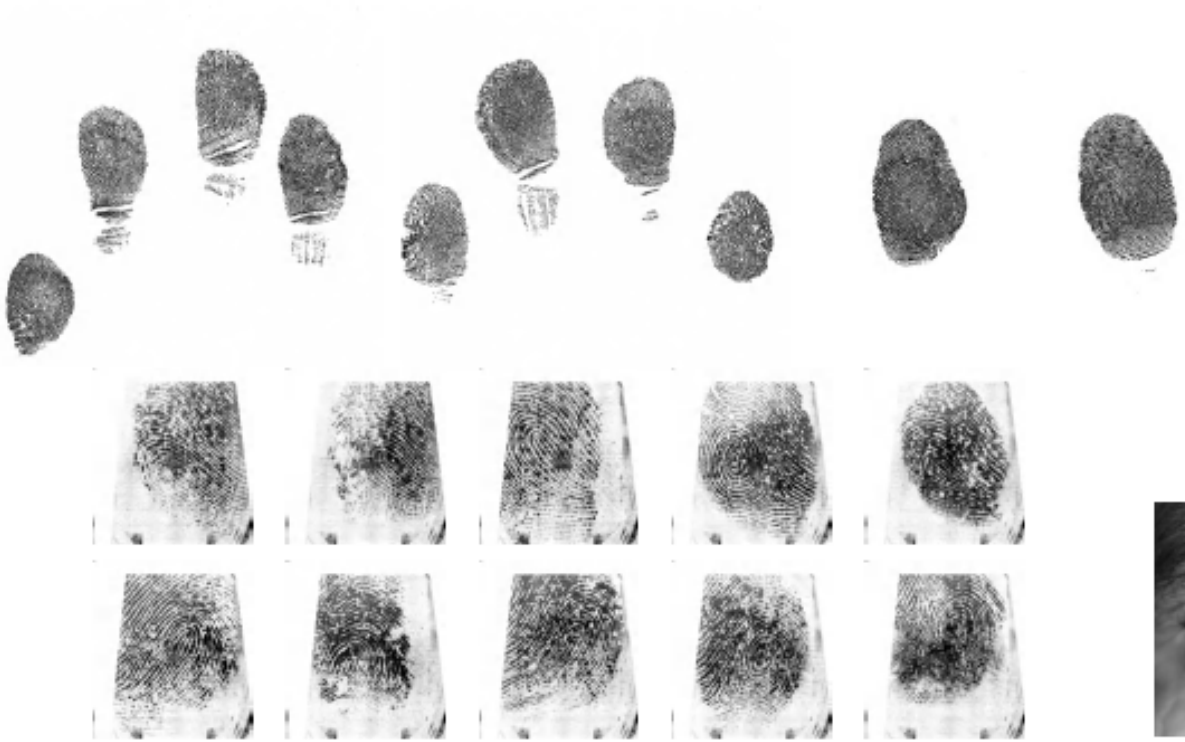
Objective

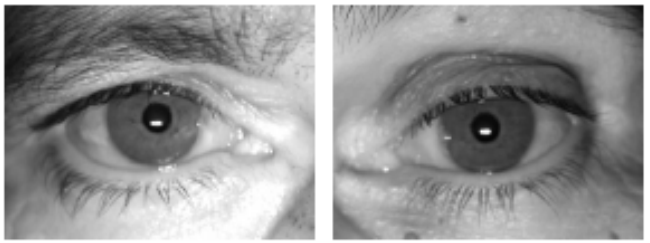
- Compare fingerprint images from two phone camera apps against images from slap readers
- Evaluate verification performance of two mobile apps for ~300 subjects with different demographics

Challenge: contactless v. contact-based (legacy) fingerprint matching

Motivation

Mobile camera capture in Aadhaar Authentication





Aadhaar enrollment

https://uidai.gov.in/

Aadhaar Authentication

Authentication Requirements

- High accuracy, usability, throughput
- Low operator involvement
- Difficult capture environment & demographics

Replace contact-based reader by contactless phone camera

https://uidai.gov.in/

Aadhaar Authentication Protocol

- First attempt: any finger (usually right thumb)
- Failure: try any other finger (usually right index)
- Failure: authenticate by mobile One Time Password (OTP)

Right thumb

Right ring finger

Protocol for Mobile App evaluation

Two images each of
RT, LT, RI, LI fingers

Station 1:
Consent Form & Reimbursement

March 4-10, 2018

Station 5: App 2 capture

Station 2: Face Capture

Station 4: App 1 capture

Station 3: Slap prints (enrollment)

Data Capture Environment #1

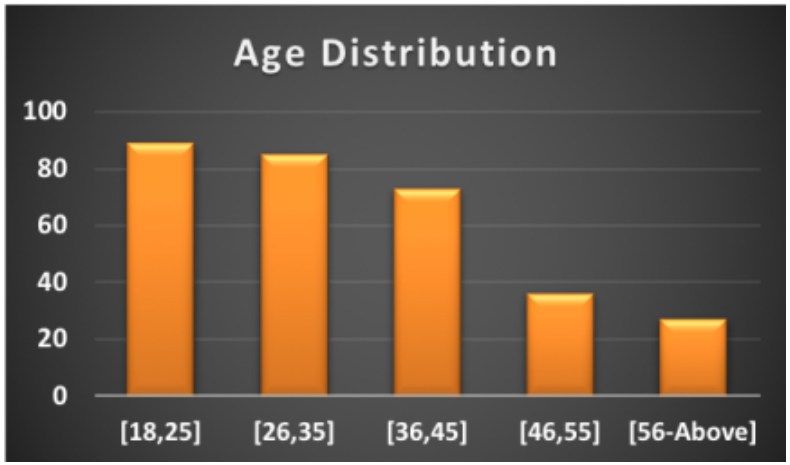
MNIT Jaipur Lecture Theatre

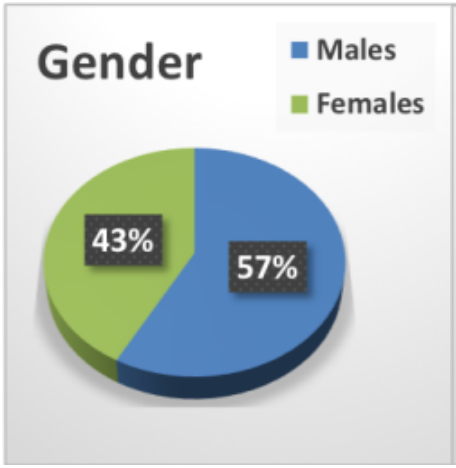
Data Capture Environment #2

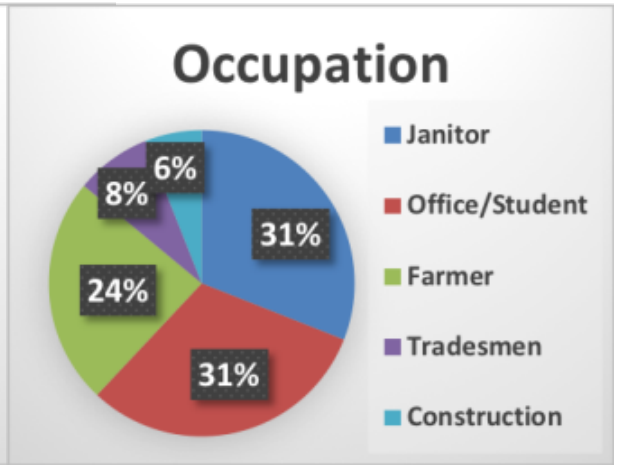
Village of Jhunjhunu; courtyard covered with a canopy

Subject Demographics

Total no. of Subjects: 309







SLK20 USB Touch Fingerprint Reader

Used it to capture fingerprints for about 60 subjects

http://www.silkid.com/wp-content/uploads/2017/02/Silk20-Reader-Brochure-v0.7.pdf

Subject 1: Fingerprint Images

Male, 42 yrs., gardener

	RT	RI	LT	LI
CrossMatch				
App 1				
App 2				

Subject 1: Fingerprint Images

Male, 42 Yrs., Gardener

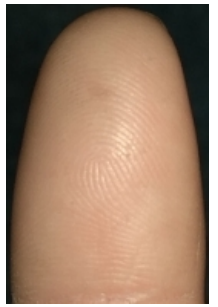
RT RI LT LI

CrossMatch

SilkID

Subject 2: Fingerprint Images

Female, 45 yrs., janitor

	RT	RI	LT	LI
CrossMatch				
App 1				
App 2				

Subject 2: Fingerprint Images

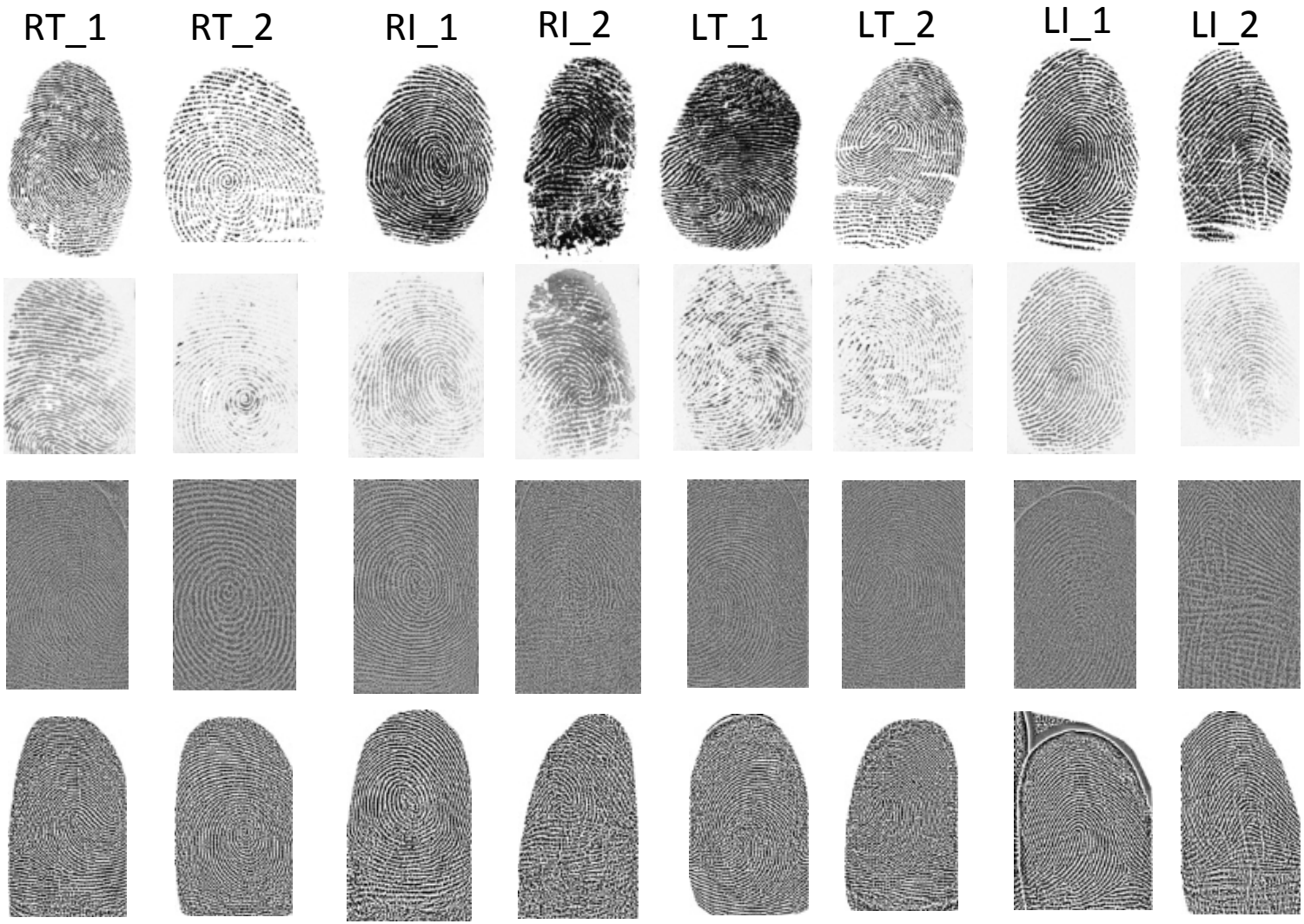
Female, 45 yrs., janitor

RT RI LT LI

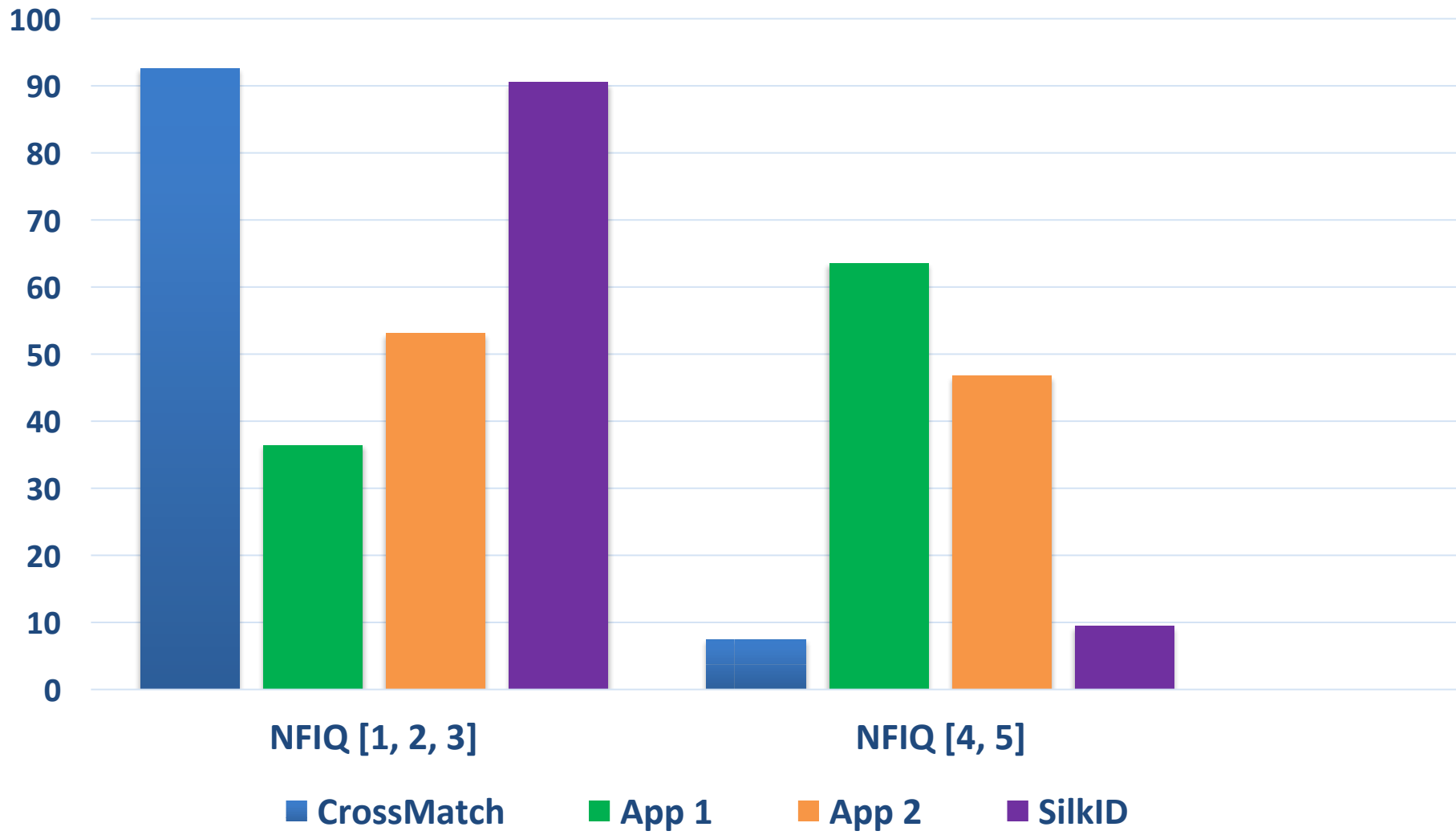
CrossMatch

SilkID

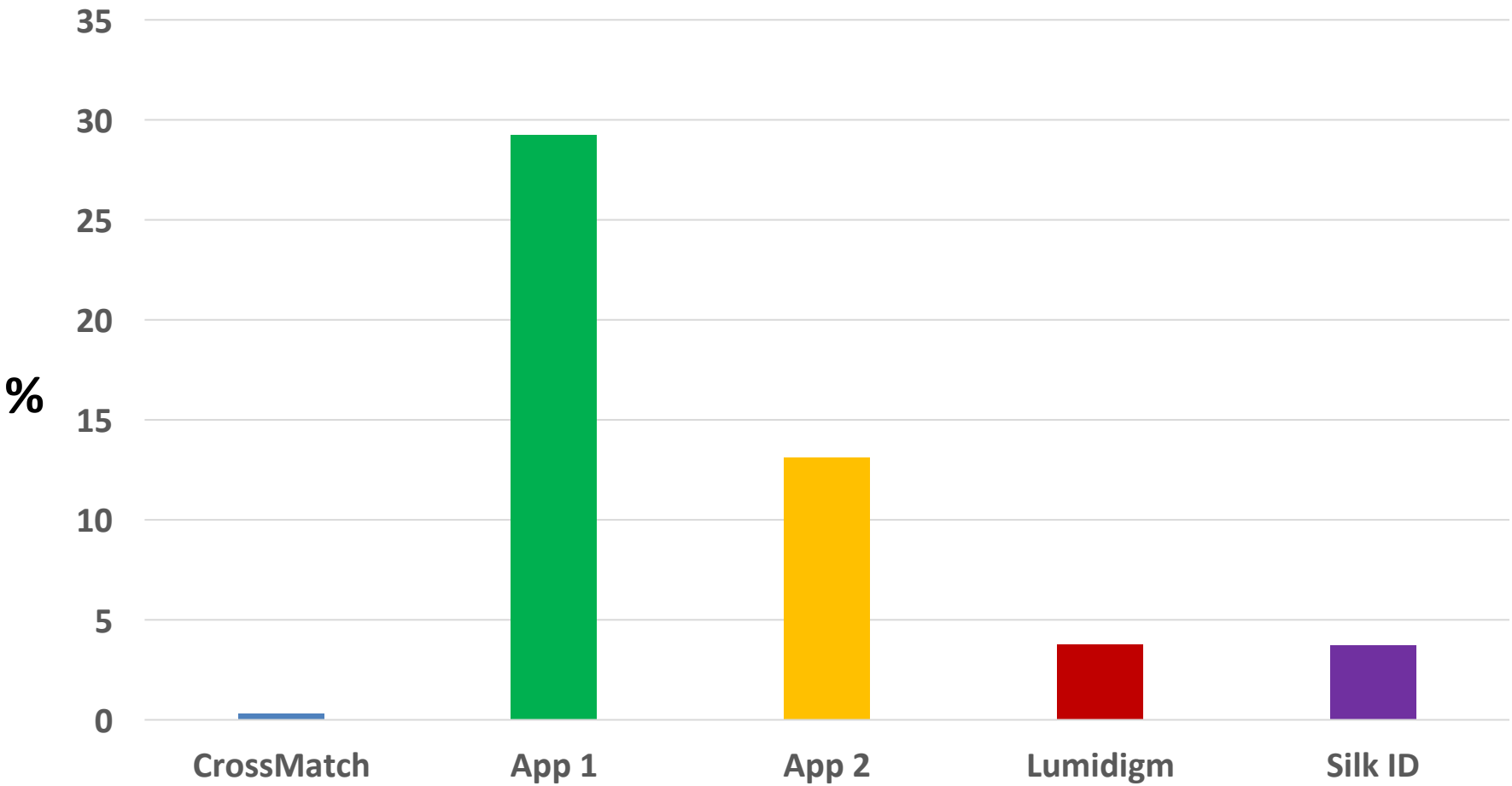
Fingerprint Images at a Glance



NIST Fingerprint Image Quality (NFIQ)



Failure to Capture



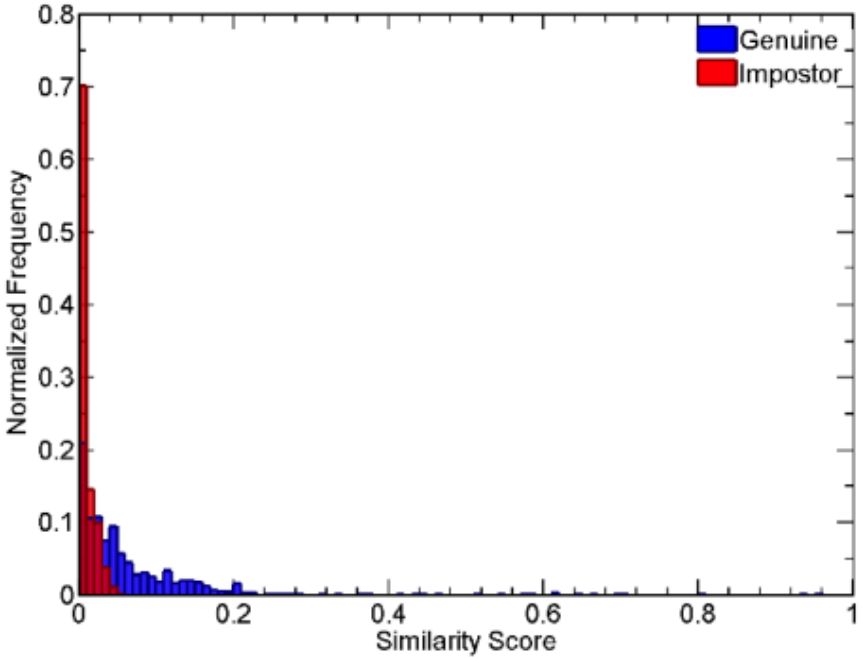
Some Challenges

Worn out/Damaged Fingers

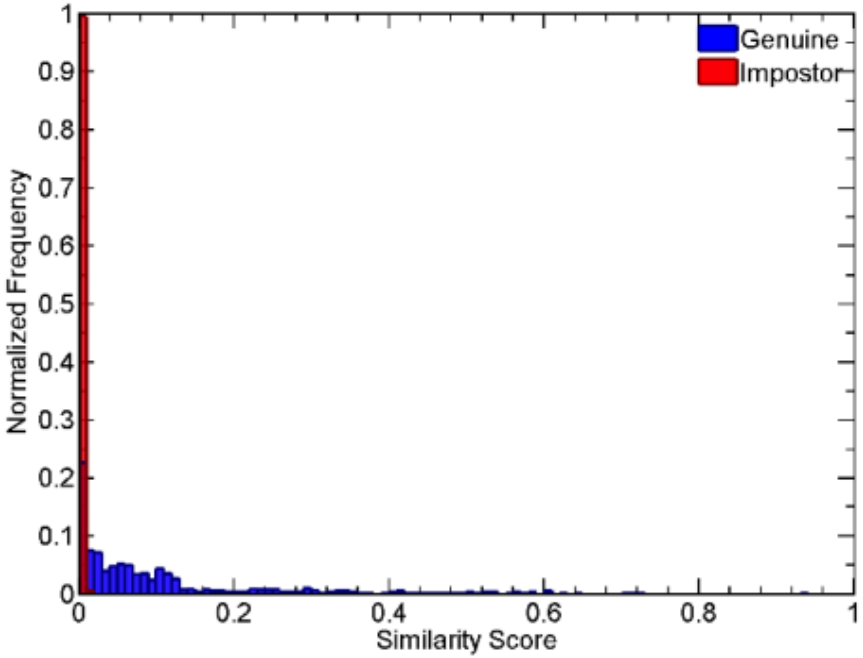
Henna

App Scores for Right Thumb

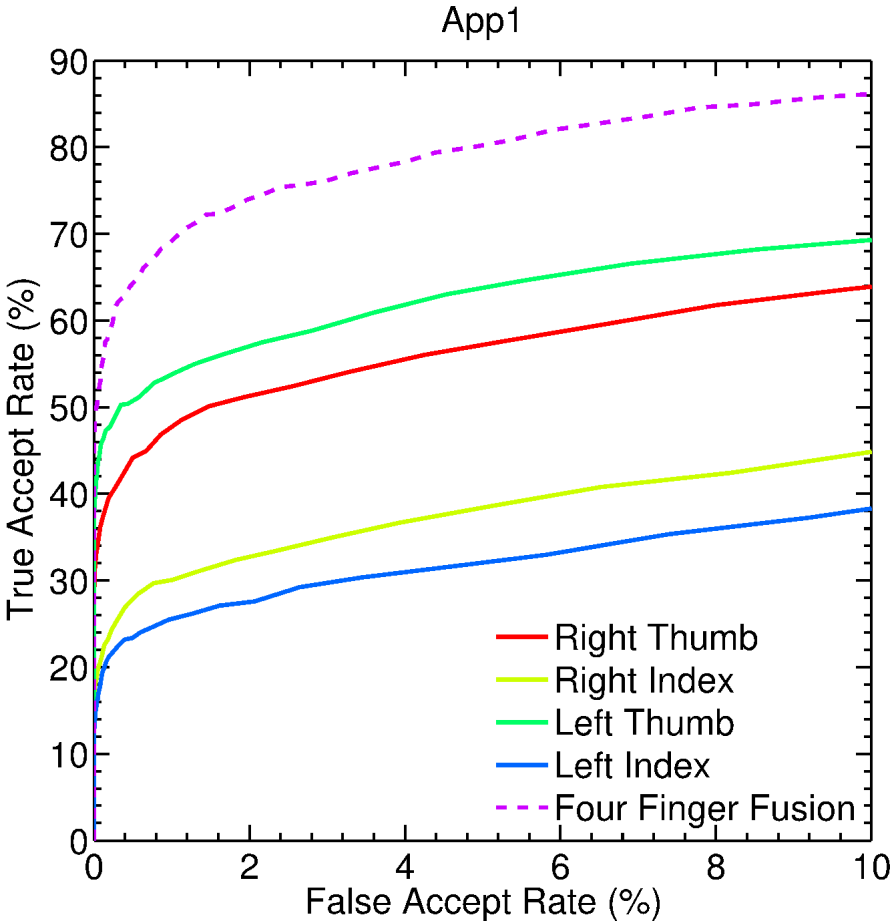
App1

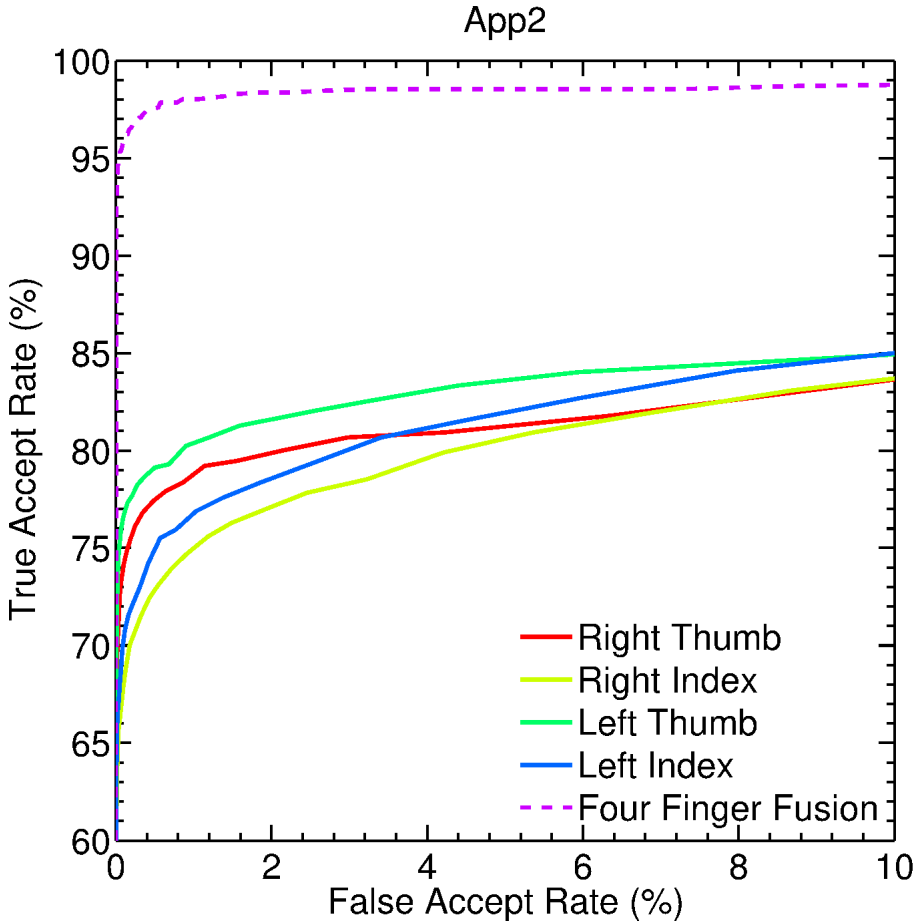


App2

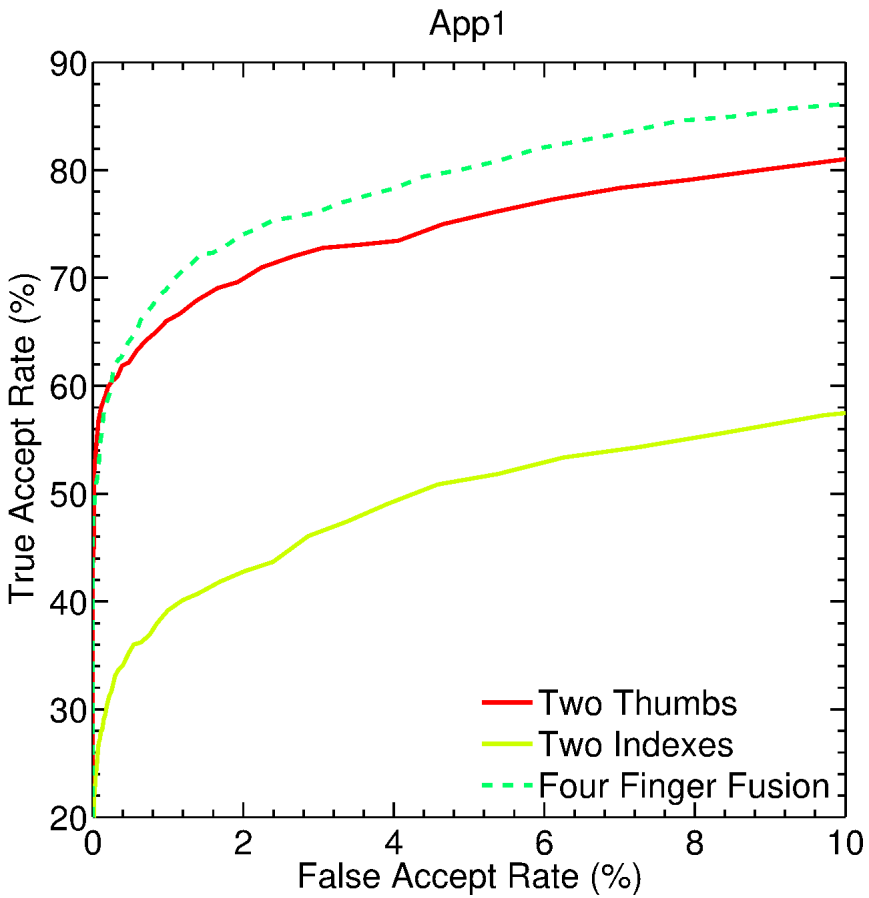


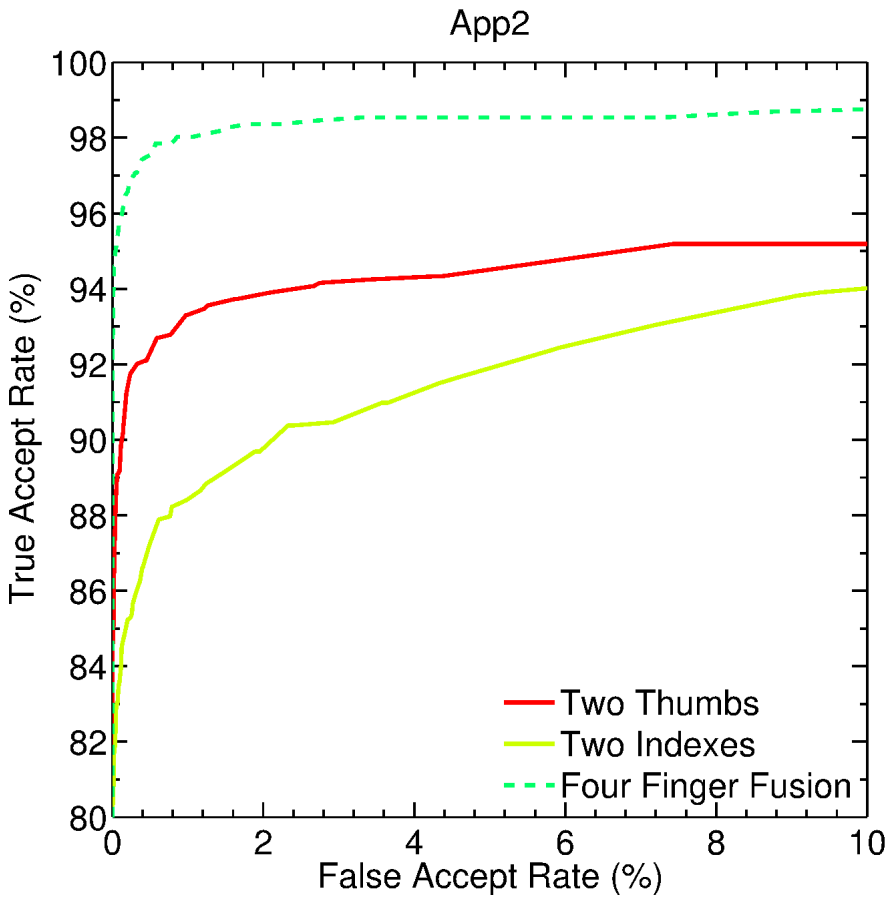
ROC for Apps


App1
True Accept Rate (%)
False Accept Rate (%)
Right Thumb
Right Index
Left Thumb
Left Index
Four Finger Fusion


App2
True Accept Rate (%)
False Accept Rate (%)
Right Thumb
Right Index
Left Thumb
Left Index
Four Finger Fusion

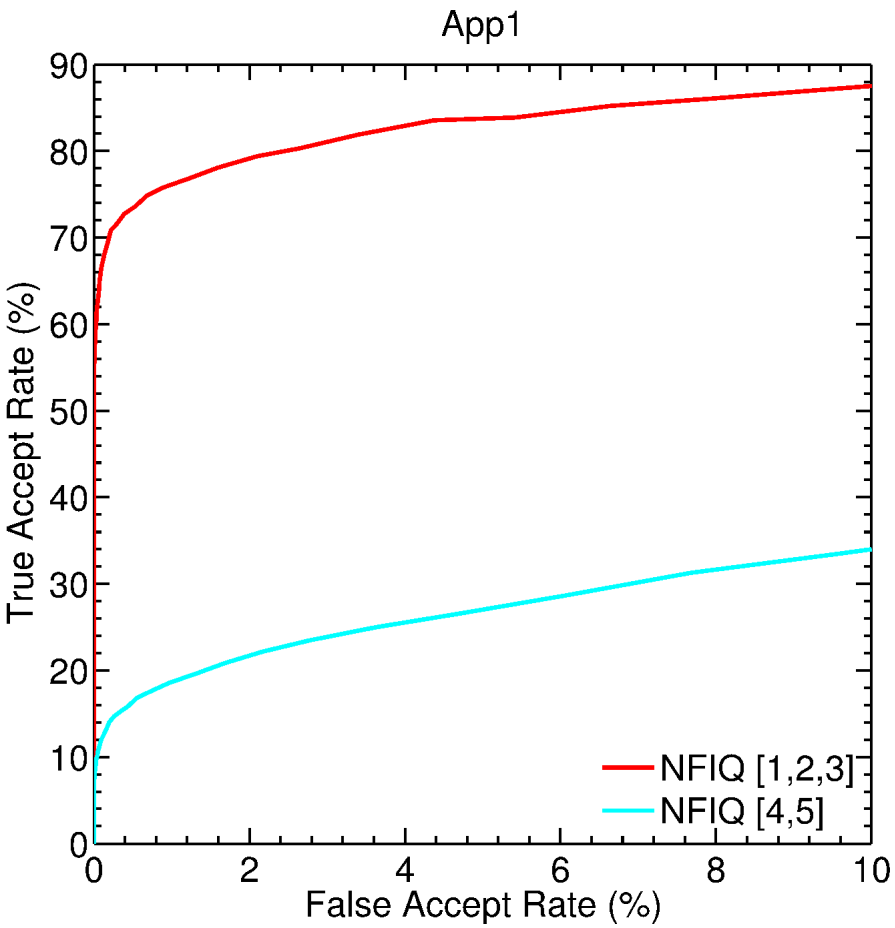
Fusion of 2 Thumbs and 2 Index Fingers





Fusion of thumbs provides more information than index fingers

NFIQ-based Performance



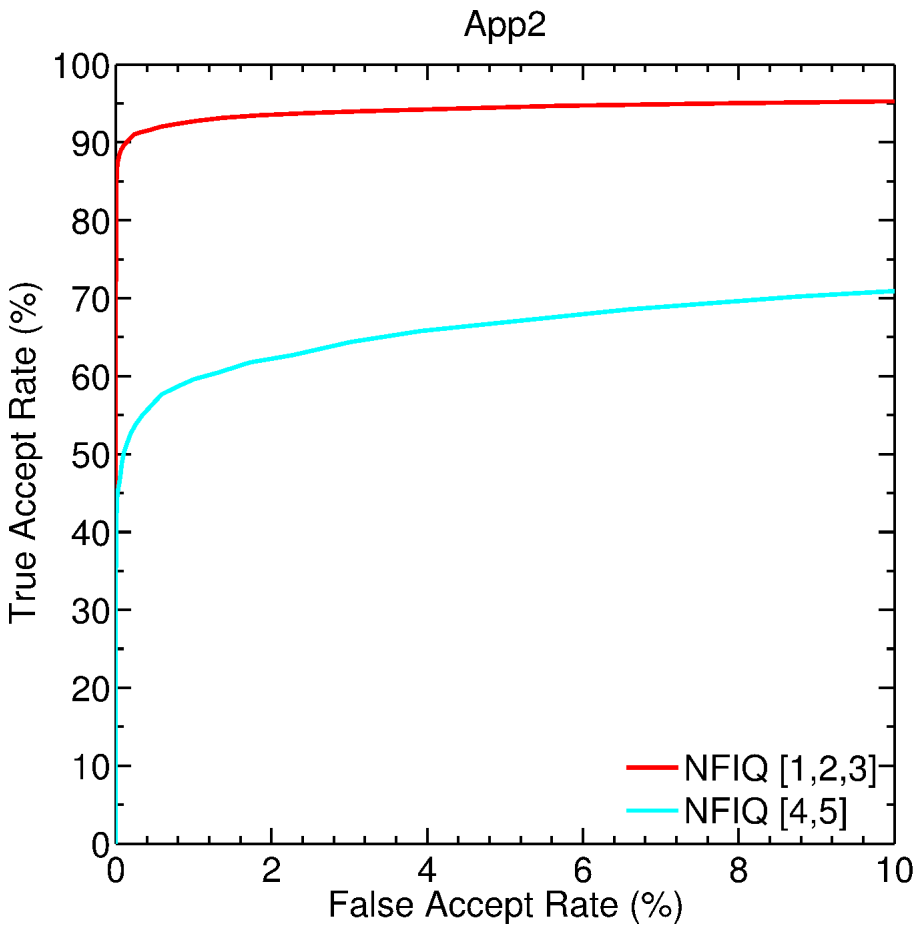
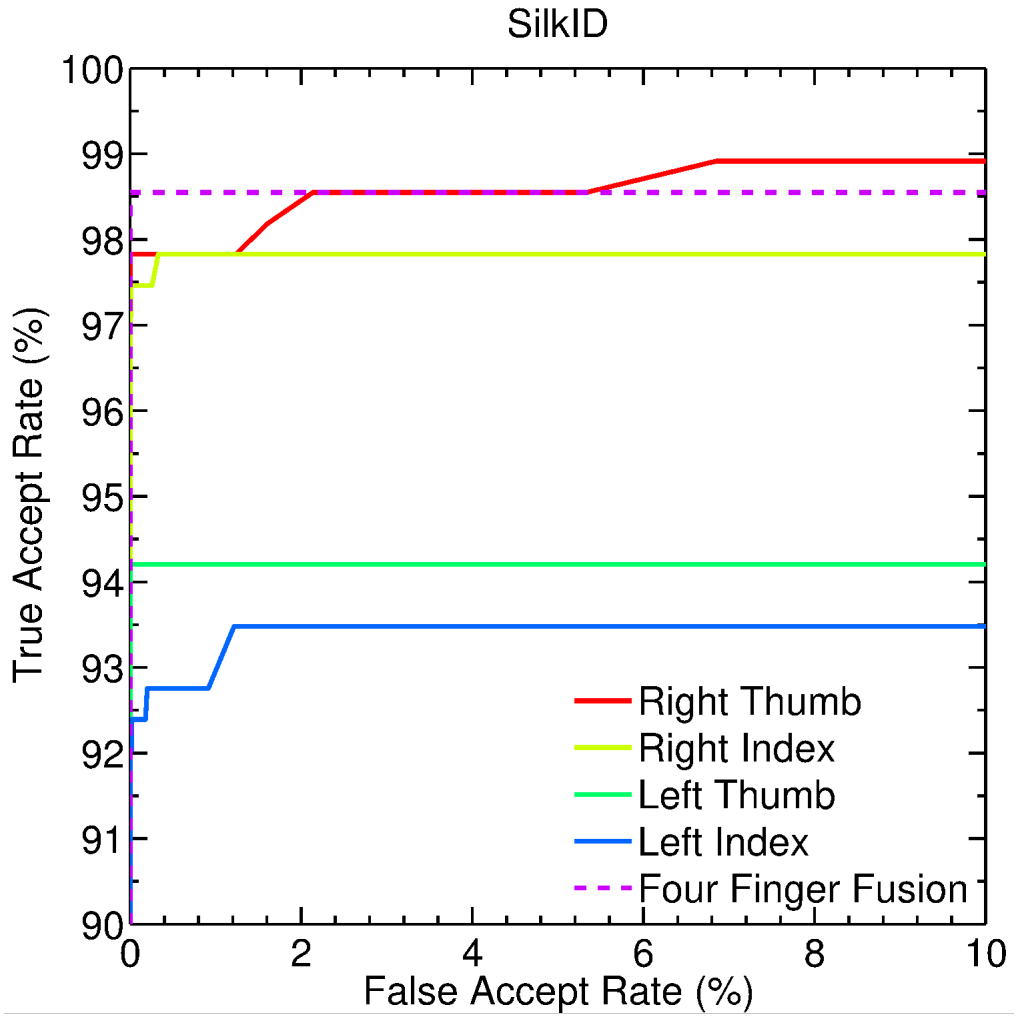


Image quality makes a difference

ROC for SilkID



Target Performance

- FAR @FRR = 2%
- For four-finger fusion, the performance is
  - App1: 56.2% @FRR = 2%
  - App2: 0.86% @FRR = 2%
  - SilkID: 0% FAR @FRR = 2%

Summary

- Evaluated 2 mobile Apps for fingerprint capture on subjects with poor finger conditions
- Scenario is difficult even for contact-based readers; poor quality fingers are better imaged with contact readers
- Teams had just 6 months to field their apps
- Additional effort needed to improve image quality, usability, throughput, etc.
- On the horizon: Optical readers in mobiles

Feedback for Improvement

- App1
  - Auto-capture needs some improvement; Sometimes, an in-focus image was not captured
  - Fine tune quality threshold so that poor quality images are not accepted
- App2:
  - Four-finger guide has limitations in that people's hands are different sizes. Sometimes subject's hand did not line up will with the four-finger guide

Acknowledgement

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