Fingerprints: Giving Child an Identity

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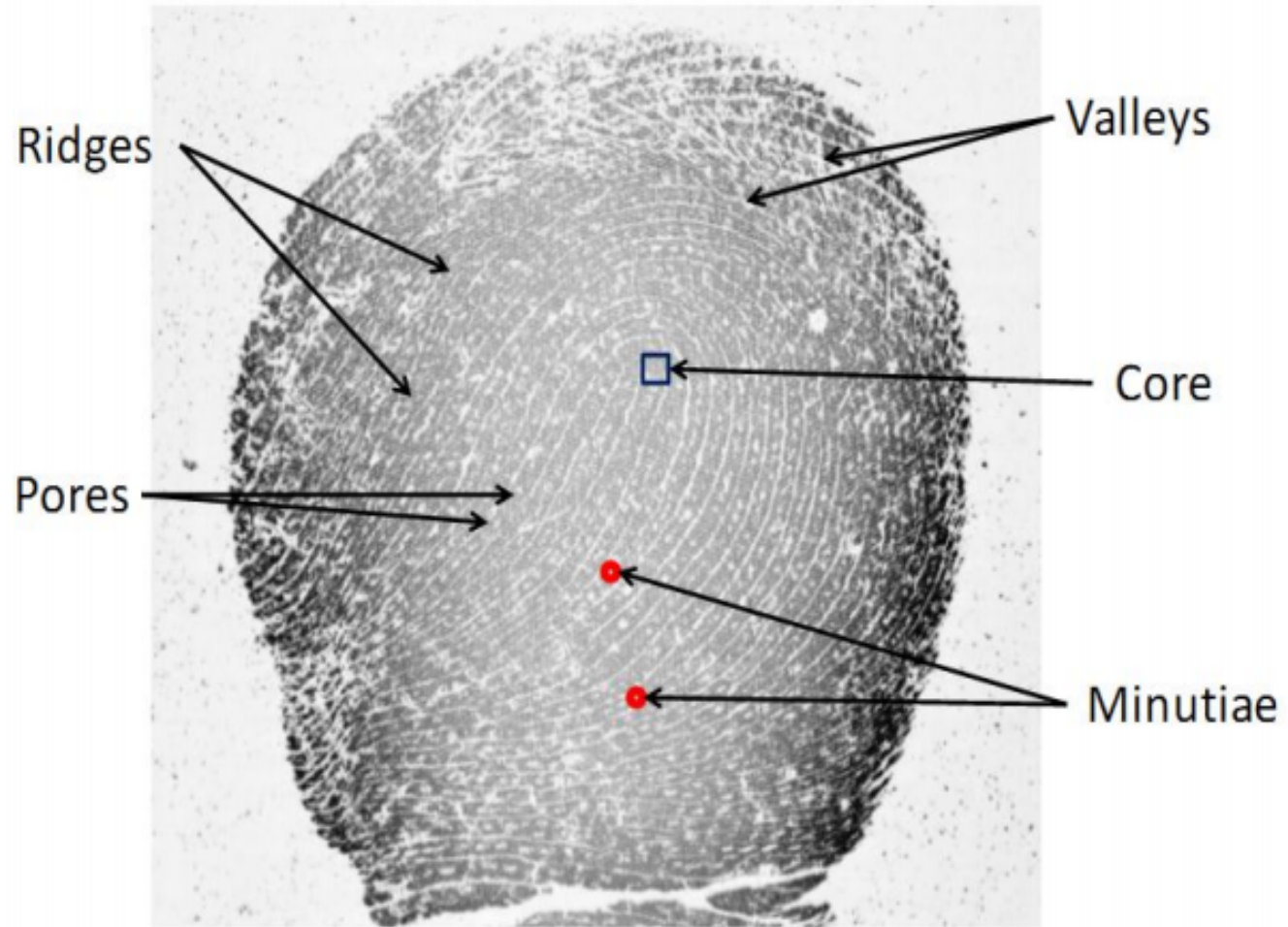
April 28, 2017

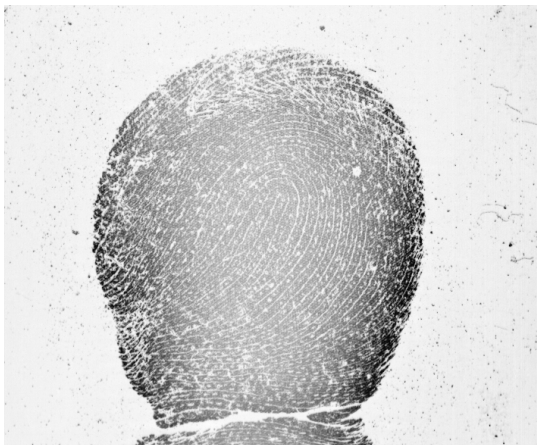# Six-hour Old Child

Six-hour Child's Fingerprint

1270 ppi NEC reader

Persistence of Biometric Recognition

6 hours old

2 days old

3 months old

National ID

~25 million births per year in India

Vaccination

Vaccination camp in Benin

Food Distribution

~1 in 2 children undernourished in Bangladesh

Missing & Abducted Children

http://miamisprings.com/news_story.asp?storyid=44

Linking Child and Parent Biometrics

this certificate to be signed by its duly authorized off

Baby's left footprint   Baby's right footprint   Mother's right thumbprint

Biometric Traits

Palmprint

Face

Footprint

Fingerprint

Iris

Ballprint

DNA?
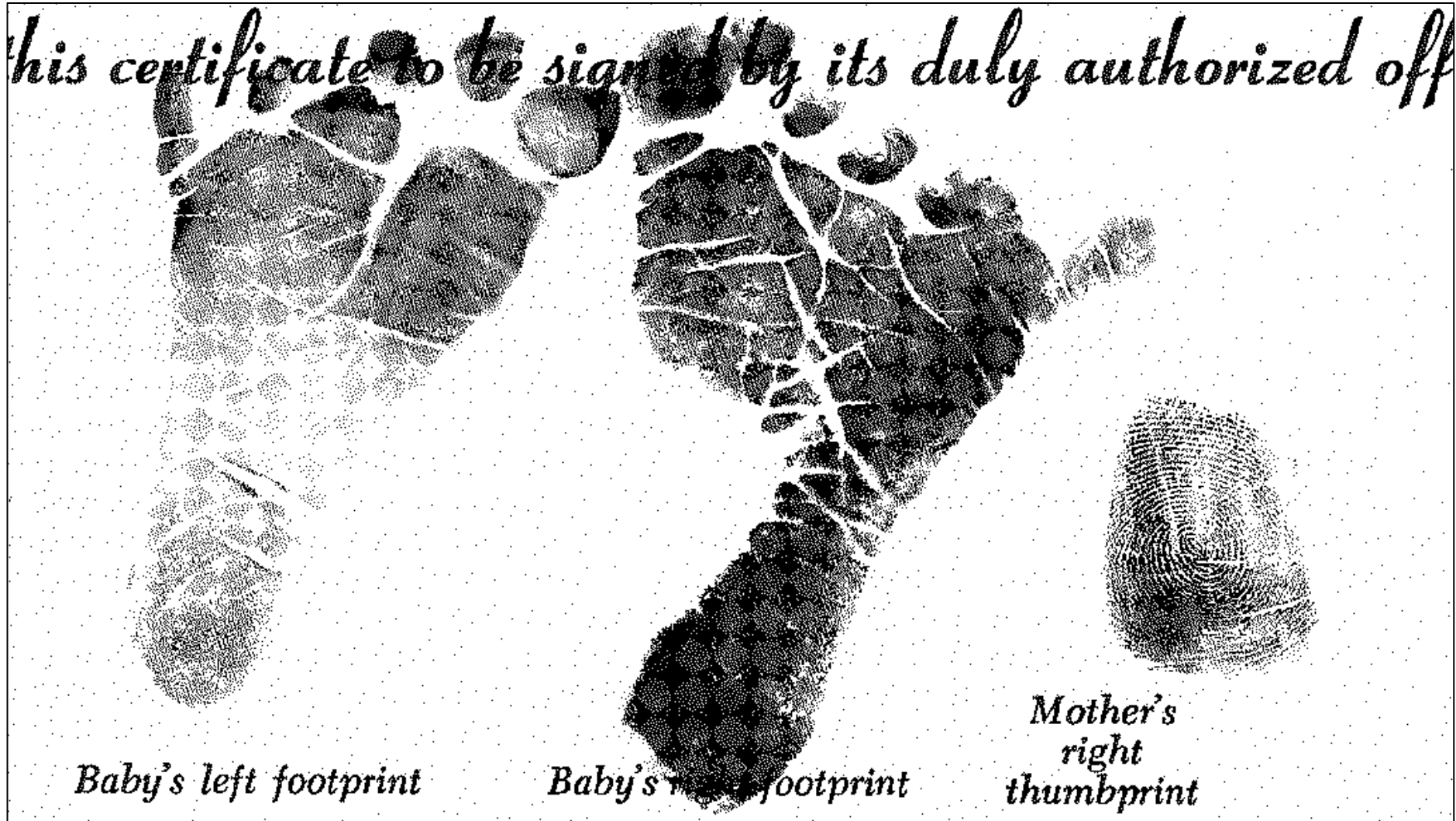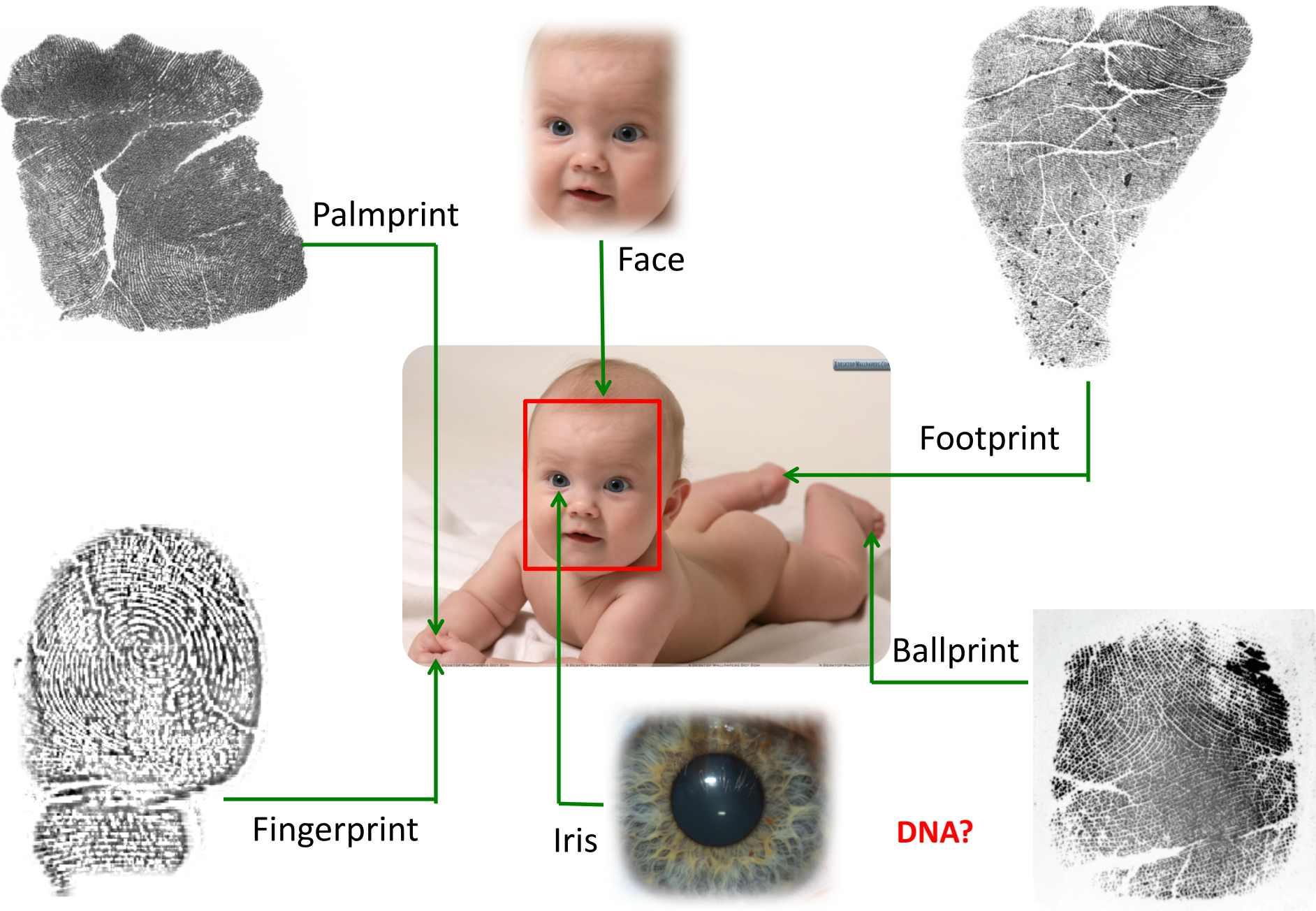
Which Biometric Trait?

Biometric trait	Ease of capture	Change over time	Parental concerns	Use cases
Face	Moderate (variation in illumination, expression, eyes closed)	Significant (facial aging)	Minor	ID documents, surveillance
Fingerprint	Relatively Easy (operator holds child's finger)	Minor	Moderate	Forensics, national ID, immigration
Iris	Difficult (child sleeping, crying)	Minor	Major (infrared illumination, obtrusive capture)	Immigration, national ID, refugees
Footprint	Difficult (dirty feet, socks and shoes)	Not known	Minor (used in U.S. hospitals)	Few
Palmprint	Difficult (fist closed, concavity in palm)	Minor	Moderate	Moderate

Objectives of This Study

- Feasibility of child recognition via fingerprints
- Conduct longitudinal study

Age: 16 months

Mar. 2015
16 months

Sept. 2015
22 months

Jan. 2016
26 months

Mar. 2016
28 months

Fingerprints from 500 ppi Digital Persona Reader

Longitudinal Fingerprint Collection
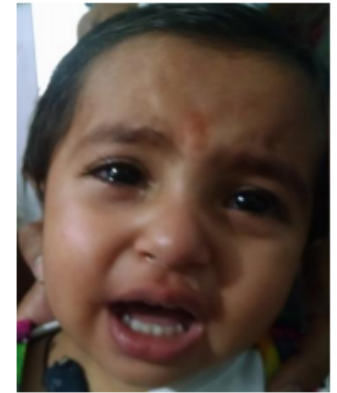

March, 2015; Sept. 2015; Jan. 2016; March 2016

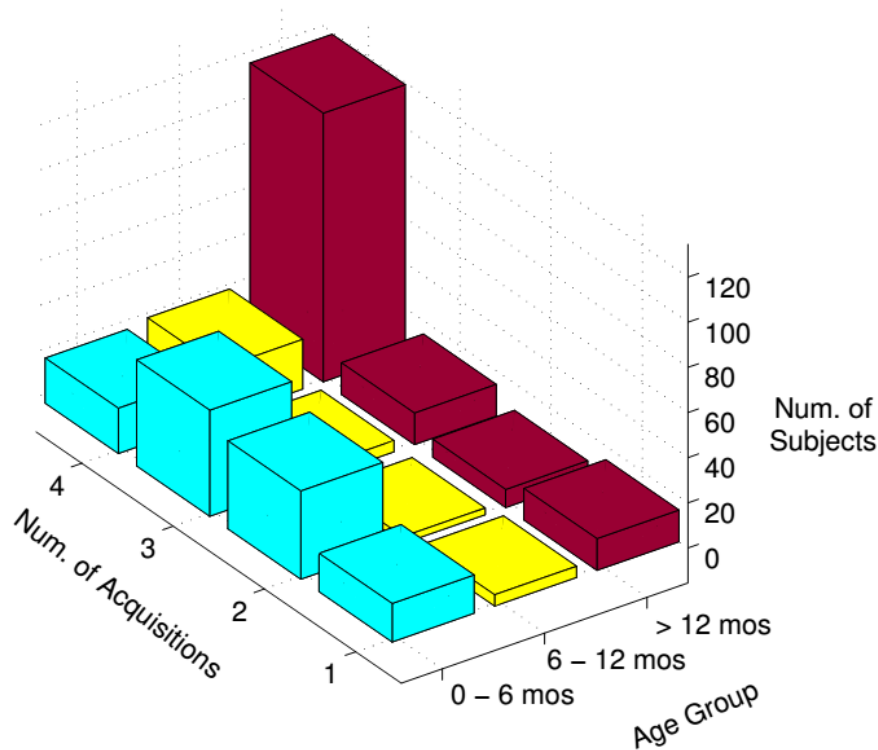|	Mar. 2015 (6 months)	Sept. 2015 (12 months)	Jan. 2016 (16 months)	Mar. 2016 (18 months)
Face				
Right Thumb 500 ppi				
Right Thumb 1,270 ppi				

Longitudinal Fingerprint Database

- 3 prints/thumb/session
- 3 face images/session
- 309 children in total
- 161 came to all 4 sessions

Subset	First Session	# Subjects (males)	Age Range (median age)	# Ret. Sess. 2	# Ret. Sess. 3	# Ret. Sess. 4	Time Lapse ($\triangle T$)
Subset A	1 (Mar. 2015)	204 (95)	0-5 (2.0) yrs	167	180	178	12 mos
Subset B	2 (Sep. 2015)	65 (33)	0-42 (6.1) weeks	*n.a.*	52	50	6 mos
Subset C	3 (Jan. 2016)	40 (18)	0-42 (7.6) weeks	*n.a.*	*n.a.*	30	2 mos

Some of the subjects in Our Database

Fingerprint Comparison: Same Finger

12 months of age

24 months of age

Input fingerprints

Fingerprint Comparison: Same Finger

12 months of age

24 months of age

Enhanced fingerprints
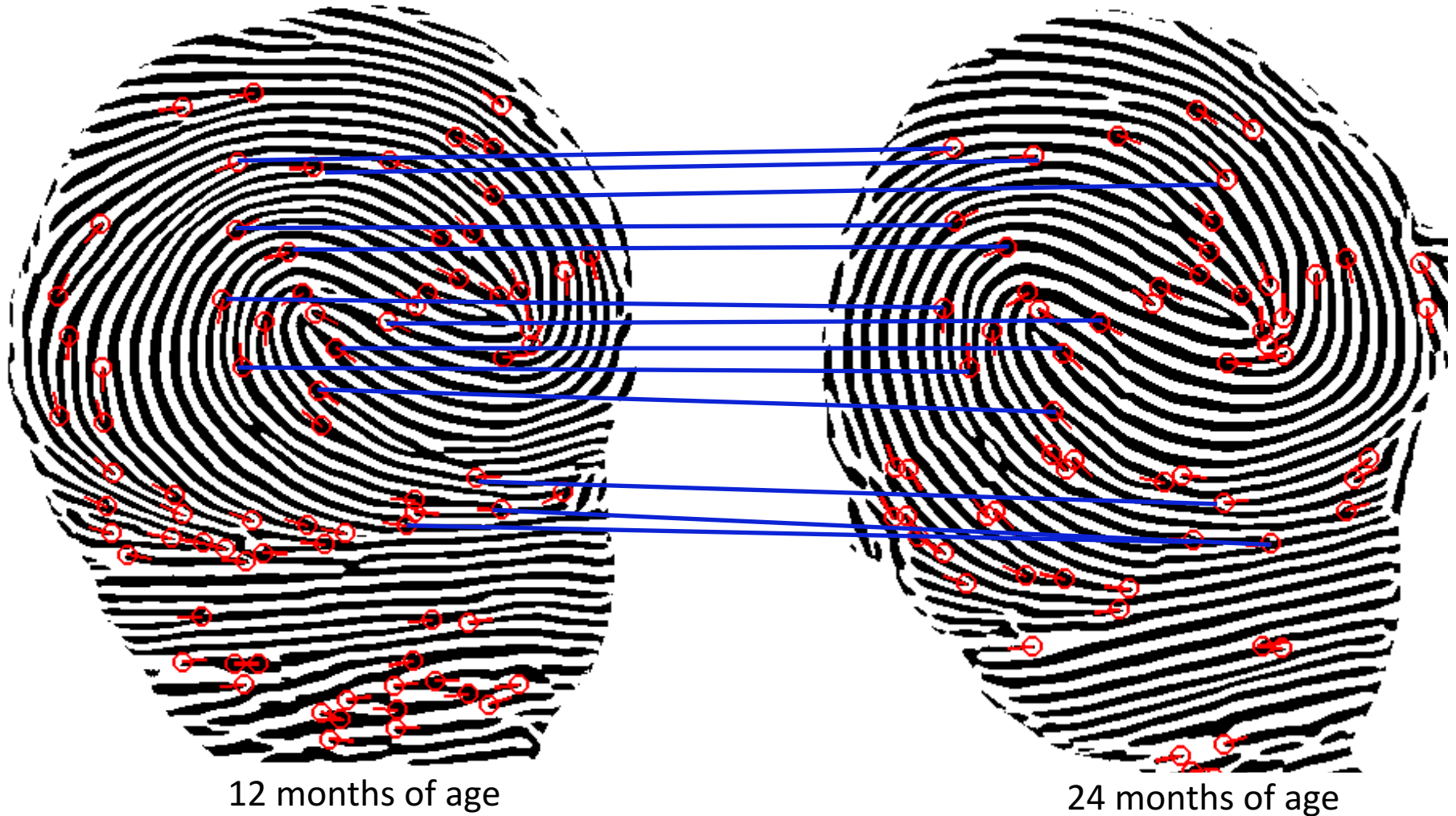
Fingerprint Comparison: Same Finger

12 months of age

24 months of age

Minutiae points

Fingerprint Comparison: Same Finger

12 months of age

24 months of age

Minutiae correspondences

Score = 9999

Fingerprint Comparison: Different Fingers

Minutiae correspondences

Score = 0

Experimental Results: Verification

- 500 ppi reader: Age at enrollment > 12 months

  - **~100% accuracy over 12 months time gap**

- 1270 ppi reader: Age at enrollment > 6 months

  - **~98.9% accuracy over 6 months time gap**

A. K. Jain, S. S. Arora, K. Cao, L. Best-Rowden and A. Bhatnagar, "Fingerprint Recognition of Young Children", *IEEE Transactions on Information Forensics and Security* 2017
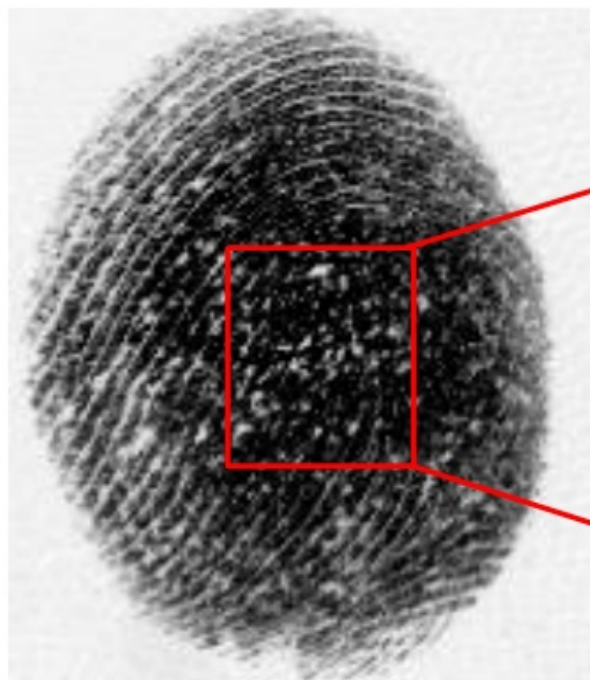
Fingerprint Image Quality

Good Quality

Poor Quality

Fingerprints of two 6 month old children collected using 500 ppi sensor

Fingerprint Image Resolution

DP U.are.U 4500 (500 ppi)

NEC Zakuro (1270 ppi)

6-week old child

Contributions

- First longitudinal fingerprint study for children

- Fingerprints of ~300 children in age group [0, 48] months, collected over 12 months, showed

  - **Children can be recognized with 99% accuracy when age at first enrolment is > 6 months**

- Future work:

  - Repeat study over longer durations
  - Develop low cost, compact, high resolution reader
  - Design robust and accurate fingerprint matcher
  - Operator training for fingerprint capture