Fingerprints: Giving Child an Identity

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MSU-Dayalbagh Affiliation

Prof. Prem Satsangi, 1961 MSU yearbook
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- Staff and students of Dayalbagh Educational Institute
- Children and their parents
M.Tech. Student Volunteers

March 10, 2015
Identity

- Who someone is: e.g., the name of a person*

Name: Baby of Renu; Gender: Female; Born September 22, 2015 approx. 6 am

*http://www.merriam-webster.com/dictionary/identity
Research Objectives

- A fingerprint reader for infants
- Robust fingerprint matching algorithm
- Contributions to Science of fingerprinting
- Monitoring health and welfare of a child

Tracking Vaccination Schedules

“Vaccine wastage rates are higher than 50% in some of the most challenging geographies. For every $100 in new vaccines purchased, $50 will never go into the arm of a child in need.” - VaxTrac

(http://vaxtrac.com/mission/challenge)
Preventing Newborn Baby Swaps

October 30, 2013: Two newborn babies born 5 minutes apart were swapped due to negligence of the medical staff at the Vijayanagar Institute of Medical Sciences (VIMS) in Bellary; a DNA test later confirmed the swap*

Identifying Missing Children

Over 800,000 children go missing in the United States every year- one child almost every 40 seconds*

* http://www.childidprogram.com/
“For children below 5 years no biometrics will be captured...These children will need to be re-enrolled...when they turn 5. Their biometrics will be updated once they turn 15.”

UIDAI is looking for a solution to enroll children who are younger than 5 years old

Source: http://uidai.gov.in/faq.html?catid=18
Fingerprints

- Ridges
- Pores
- Core
- Valleys
- Minutiae
Matching score = 668 (threshold at 0.1% FAR = 101), indicating a true match
Data Collection Protocol

• Four sessions
  – Session I (Mar. 9-11, 2015); 206 subjects
  – Session II (Sept. 21-25, 2015); 167 repeat & 66 new subjects
  – Session III (Jan. 4-8, 2016); 184 repeat & 41 new subjects
  – Session IV (Mar. 7-12, 2016); ongoing

• 3 fingerprint images/thumb (left and right)
• Face images acquired using iPhone 5/5s
• Total of 313 subjects
• 165 subjects present at all 3 sessions held so far
U.are.U 4500 HD Reader (Digital Persona)

- 500 ppi resolution
- Compact (6.5 cm x 3.6 cm x 15.56 mm)
- Auto Capture (~1 sec)

Used in all 4 image acquisitions (March, 2015; Sept. 2015; Jan, 2016; March 2016)
NEC Zakuro CMOS reader

- 1,270 ppi resolution
- Compact (7 cm x 3 cm x 8 mm)
- Tapered edge design
- Manual capture (blue button)

Used in the last 3 image acquisitions (Sept. 2015; Jan. 2016; March 2016)
Fingerprint Image Quality: 500 v. 1,270 ppi

Age at acquisition: 7 months
Parents Signing the Consent Form
Data Collection

Dr. Anjoo Bhatnagar’s clinic, Saran Ashram Hospital
Fingerprint Capture
Token of Appreciation to Parents
Challenges in Fingerprint Capture

- Motion blur and distortion in images
- Small finger size
- Dry/wet/dirty fingers
Longitudinal Data: 500 ppi images

6 months

12 months

15 months

18 months

24 months

27 months
Recognition: Verification v. Identification

Verification:
- 1:1 comparison
- Query image vs. Enrolled image

Identification:
- 1:N search
- Query image vs. Database

Claimed identity
Established identity
## Verification Performance

Two thumbs; one impression/thumb

<table>
<thead>
<tr>
<th>Time gap</th>
<th>500 ppi DP reader (1270 ppi NEC reader)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Accuracy* (age &gt;1 year)</td>
</tr>
<tr>
<td>Session 2 vs. Session 1</td>
<td>6 months</td>
</tr>
<tr>
<td>Session 3 vs. Session 1</td>
<td>9 months</td>
</tr>
<tr>
<td>Session 3 vs. Session 2**</td>
<td>3 months</td>
</tr>
</tbody>
</table>

* True accept rate (TAR) @ false accept rate (FAR) = 0.1%
** Age at session 2 for all the kids was at least 6 months
Verification Example

7 months old (at session 2) girl

DP sensor (failure)

NEC Sensor (successful)

Query fingerprints (session 3)

Gallery fingerprints (session 2)
# Identification Performance

Two thumbs – one query fingerprint/thumb

<table>
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<tr>
<th>Age gap</th>
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<th>NEC sensor (1,270 ppi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Session 2 vs. Session 1</td>
<td>6 months</td>
<td>100%</td>
</tr>
<tr>
<td>Session 3 vs. Session 1</td>
<td>9 months</td>
<td>100%</td>
</tr>
<tr>
<td>Session 3 vs. Session 2**</td>
<td>3 months</td>
<td>100% (100%)</td>
</tr>
</tbody>
</table>

* Accuracy denotes rank-10 identification rate
** Age at session 2 for all the kids was at least 6 months
Identification Example

10 months old (at session 2) boy

DP sensor (failure)

NEC Sensor (successful)

Query fingerprints (session 3)

Gallery fingerprints (session 2)
Summary

• MSU, DEI, Saran hospital and NEC are addressing two fundamental problems of significance
  – Identifying a child based on fingerprints
  – Persistence of fingerprint recognition

• Recognition results show
  – 500 ppi reader is adequate to recognize a child > 12 months
  – 1,270 ppi reader can recognize a child > 6 months

• Ongoing research
  – Improvements to NEC 1270 ppi reader
  – Fingerprint enhancement & recognition for children < 6 mos.
Giving Infants an Identity: Fingerprint Sensing and Recognition

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ABSTRACT

There is a growing demand for biometrics-based recognition of children for a number of applications, particularly in developing countries where children do not have any form of identification. These applications include tracking child vaccination schedules, identifying missing children, preventing fraud in food subsidies, and preventing newborn baby swaps in hospitals. Our objective is to develop a fingerprint-based identification system for infants (age range: 0-12 months)¹. Our ongoing research has addressed the following issues: (i) design of a compact, comfortable, high-resolution (>1,000 ppi) fingerprint reader; (ii) image enhancement algorithms to improve quality of infant fingerprint images; and (iii) collection of longitudinal infant fingerprint data to evaluate identification accuracy over time. This collaboration between Michigan State University, Dayalbagh Educational Institute, Saran Ashram Hospital, Agra, India and NEC Corporation, has demonstrated the feasibility of recognizing infants older than 4 weeks using fingerprints.

Wide in many developing countries to increase vaccination coverage (e.g. Mission Indradhanush in India²), however, vaccine wastage rates are still estimated to be higher than 50% in some of the most challenging geographies³. One of the main reasons for this confounding statistic is the lack of an effective method to track vaccination schedules of infants, primarily because in most developing countries infants and, in most cases, even parents, do not have any form of identification documents.

Swapping of newborns after birth is another major problem because of overcrowded hospitals and inadequate maternity ward provisioning. To alleviate this problem, it is necessary to identify newborns and associate their identities to their mothers. In the United States, it is estimated that 800,000 children go missing every year - a child every 40 seconds⁴. Many of them cannot be easily located and identified because there is no known method to reliably identify infants.

Given the growing demand for a method to identify infants in several healthcare and social welfare applications, a number of international healthcare organizations, non-