# A study of children's fingerprint enhancement & recognition

[1]Apurva D. Dhawale

1Department of CS & IT,
Dr. Babasaheb Ambedkar Marathwada University, Aurangabad, India

***Abstract:*** This Security plays a very vital role in one's life. Biometrics consists of methods for uniquely recognizing humans based upon one or more physical or behavioral Parameters. The children must have their unique identity after birth itself. Every child possesses all the physical & behavioral parameters of biometric system which have been developed based on fingerprints, facial features, voice, hand geometry, handwriting, iris and retina etc. The children identification based on these parameters is possible now. The unimodal biometric employs single biometric trait (either physical or behaviour trait). The children identification based on fingerprint recognition is coming into limelight these days. This gives the child security from the risk of children trafficking, sold prostitution, kidnapping etc where sometimes the identity of children is lost because of face injuries, acid attacks etc.

***IndexTerms*** **- Mindtct, Bennin, Standard deviation, Persistence, Vaccinations, Trafficking, rape, Orphanage, assault.**

## I. INTRODUCTION

In today's world, virtually everything is dependent on knowing with a high degree of assurance 'who' we are dealing with. Cards can be lost, or stolen, or shared; ID numbers and passwords are easily forgotten, especially for younger students, or shared. So, biometric identification is the purest and most non-discriminatory form of personal identification [2].

"Let no one despise the ridges on account of their smallness, for they are in some respects the most Important of all anthropological data. They have the unique merit of retaining their peculiarities unchanged throughout life, and afford in consequence an incomparably surer criterion of identity than any other bodily feature." - Galton [1].

There are many physiological & behavioral traits we can consider. The research with respect to a child includes children's face, fingerprint, Iris, Footprint, palmprint & Face for child identification & verification. The difficulty level for the acquisition of these traits also varies. It's observed that the child identification & verification is a challenge because the techniques we use for database of adult person database image pre-processing & feature extraction are going to be applied on child database, & the results may vary.

.

## II. RELATED WORK

In 1899, Galton first captured ink-on-paper fingerprints of a single child from birth until the age of 4.5 years, manually compared the prints, and concluded that "the print of a child at the age of 2.5 years would serve to identify him ever after". Since then, ink-on-paper fingerprinting and manual comparison methods have been superseded by digital capture and automatic fingerprint comparison techniques, but only a few feasibility studies on child fingerprint recognition have been conducted [9].

Identification and recognition of children and infants have come to limelight in recent years. Recently, Jain et al. in 2016, collected fingerprint data of 309 children between 0-5 year's age over a span of a year in four different phases. Their work aims at investigating the persistence of fingerprint recognition [10].

Table1: Comparison Of Existing Child Fingerprint Recognition Studies

| Study | #Subjects | Age range (at enrollment) | Longitudinal Data Capture(Time Lapse) | Conclusion |
|---|---|---|---|---|
| Galton (1899) | 1 | 0 yrs. | Yes (4.5 yrs.) | Fingerprints captured at the age of 2.5 yrs. Can be used for child recognition |
| TNO (2005) | 161 | 0-13 yrs. | No (n.a.) | Difficult to obtain clear fingerprints from children under 4yrs. Of age. |
| BIODEV II (2007) | 300 | 0-12 yrs. | No (n.a.) | Challenging to acquire fingerprints of children below 12 yrs of age. |
| UltraScan (2006- | 308 | 0-18 yrs. | Yes (3 yrs.) | No specific insight into fingerprint capture of young children. (0-5 yrs) |

| | | | | |
|---|---|---|---|---|
| 2009) | | | | |
| JRC (2013) | 2611 | 0-12 yrs. | Yes (2-4 yrs.) | Fingerprint recognition of children younger than 6 yrs is difficult. |
| Jain et. al. | 309 | 0-5 yrs. | Yes (1 yr.) | Feasible to recognize children at least 6 months of age using fingerprints |

Bharadwaj et. Al, assert that despite of challenges of capturing face in newborns such as variation in face expression, expressions and pose, etc. newborns can be distinctly identified through face biometric [7].

In 2008, Weingaetar et al. compared performance of footprint against palm prints for 106 new-born kids. It was observed that palm prints were of better quality than foot prints [8].

Jain et al in 2014, collected 1,600 fingerprint images (500 ppi) of 20 infants and toddlers captured over a 30-day period in East Lansing, Michigan and 420 fingerprints of 70 infants and toddlers at two different health clinics in Benin, West Africa. They devised the following strategies to improve the fingerprint recognition accuracy when comparing the acquired fingerprints against an extended gallery database of 32,768 infant fingerprints collected by VaxTrac in Benin [4].

Table2: Details Of Study Of Biometric Trait Capture, Persistence & Parental Concerns

| Biometric Trait | Ease of capture | Persistence | Parental Concerns |
|---|---|---|---|
| Face | Moderate | Low(Facial aging) | Minor |
| Fingerprint | Difficult | High | Moderate |
| Iris | Difficult | High | Major(infrared illumination, obtrusive capture process) |
| Footprint | Difficult | Not known | Minor(Routinely used in U.S. hospitals) |
| Palmprint | Difficult | High | Moderate |

Jain et al in 2015 proved that the use of fingerprints for recognition of 0-4 year-old children appears promising [5]. Jain et al in 2016, has demonstrated the feasibility of recognizing infants older than 4 weeks using fingerprints [6].

Protichi Basak in 2017 tried to fuse fingerprint, iris, & face modalities of children and improved the performance [3].

## III. PROPOSED METHODOLOGY AND DISCUSSION

### 3.1 Major challenges for Acquisition of fingerprint images

**3.1.1** Anil K. Jain, Kai Cao and Sunpreet S. Arora acquired the images of children fingerprint with following issues:

The first major challenge is to capture good quality fingerprint images. This is primarily because of the following reasons:

• **Semi To Non-Cooperative Subjects:** Most infants and toddlers do not place their fingers on the fingerprint sensor on their own. It is difficult to force them to place their fingers properly on the sensor for more than a few seconds. As a result, often there is insufficient time for the fingerprint sensors to capture good quality images. Typically, one has to hold the child's fingerprint on the sensor and apply some pressure.

• **Oily/wet finger skin:** The finger skin of newborns usually has a waxy coating on it reportedly due to a higher percentage of sterol esters to prevent excessive wetting of finger skin. Besides, infants and toddlers typically have the habit of sucking their fingers, which affects their finger skin texture. The texture of oily/wet finger skin directly manifests itself in the captured fingerprint impression, thereby affecting the fingerprint image quality.

• **Small sized fingers:** Most fingerprint sensors are designed to sense adult fingers. When presented with

Smaller sized infant and toddler fingers, the finger detection module built into the sensors sometimes fails to detect the presence of the finger to trigger the fingerprint capture process [4].

The desirable characteristics of a fingerprint sensor for capturing fingerprints of infants and toddlers are:

(i) Portability because the sensor has to be brought close to the child's finger for capturing fingerprints,

(ii) Compact and Comfortable sensor platen to be able to place the child's finger properly on the sensor platen to initiate the fingerprint capture process, and

(iii) Fast Capture Speed because it is difficult to hold the child's finger steady on the sensor platen for more than a few seconds in most cases.

U.are.U4500: a 500 ppi optical fingerprint reader from Digital Persona provides the best quality fingerprint images of infants and toddlers [4].

**3.1.2** Protichi Basak,Saurabh De used Crossmatch l-scan patrol slap fingerprint optical scanner with 500 ppi having 81x 76mm image capture area. They ensured that the scanner could be kept in low-height tables so that the children can reach the scanner easily. They collected samples of 119 subjects with 5 samples per subject.

They faced major challenges as:

- Fingerprint capture is most time consuming & tedious.
- Children below 3 years have soft n smooth skin, excessive dry n thin fingers so they applied moisturizer on fingers to get fine features.
- External pressure was required to get each sample.
- Kids did not put their fingers on scanner for entire duration so manual capture was needed.

### 3.2 Acquisition of fingerprint images

**3.2.1** ANIL K. JAIN, KAI CAO AND SUNPREET S. ARORA

Fingerprint images captured as follows:

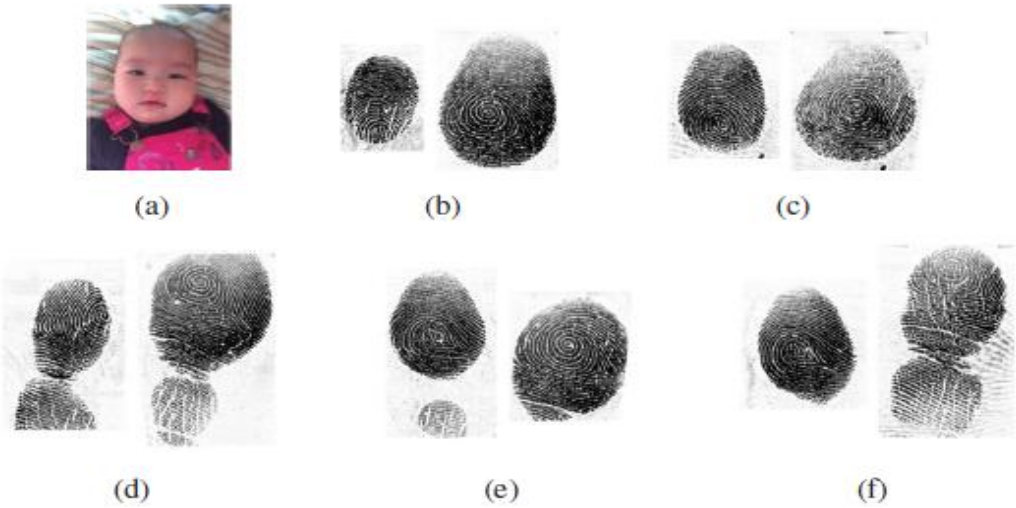


Figure1. Acquired fingerprint images

The acquired fingerprint images are shown above. The images can be acquired periodically & changes can be observed. This gives the raw input images which are sometimes needed to be taken with manual pressure. So enhancement must be done.

**3.2.2** Protichi Basak,Saurabh De

Fingerprint images captured as follows:

Figure2. Acquired fingerprint images

The input images are enhanced for further feature extraction. The fingerprint image capture is a bit tedious job because the baby is not always ready, he/she might be sleeping, crying etc. And parents concern is also very important factor.

### 3.3 Methodology

#### 3.3.1 ANIL K. JAIN, KAI CAO AND SUNPREET S. ARORA

Following Strategies were applied to perform feature extraction & matching

- Up sample the acquired image
- Fuse match scores of multiple enrolled templates
- Fuse match scores of two fingers
- Update gallery over time

#### 3.3.2 Protichi Basak,Saurabh De

Following Strategies were applied to perform feature extraction & matching

- Ridge ending and bifurcation were extracted by using Mindtct algorithm
- Scores are normalized using tan-hyperbolic function. The normalized scores are added to generate the final matching score for each subject.

## IV. EXPERIMENTAL RESULTS

### 4.1 ANIL K. JAIN, KAI CAO AND SUNPREET S. ARORA

A total of 1,600 fingerprint images of four fingers each from 20 subjects were collected over a period of 30 days in East Lansing, United States and 420 fingerprints of two fingers each from 70 subjects were collected in two different health clinics in Benin.Here FAR was 0.1 % & the identification rate is 89.6%.

### 4.2 PROTICHI BASAK,SAURABH DE

They observed large improvement in matching accuracies. When using single finger, max accuracies around 80% with standard deviation high as 4-5%. However, on using all 10 fingers, high FAR of 97% with low standard deviations of around 1% are observed.

## V. CONCLUSION

This biometric system gives the identification techniques for children to help them give identity for lifetime. The comparison of both the techniques shows that the fingerprint trait can be used for infant, child or toddler identification.

The children do have a fingerprint which can be captured with sufficient fidelity & used reliably to recognize the child. This will surely help the people to reduce the lost child complaints, and orphanage children cases. The Rape victims may also be verified by this fingerprint recognition technique.

## REFERENCES


**[1]** F. Galton, Finger prints. Macmillan and Company, 1892.

**[2]** https://findbiometrics.com/biometric-identity-assurance-for-school-children-enhancing-child-security-safety-and-privacy/

**[3]** Protichi Basak, Saurabh De, "Biometric Recognition for Kids", BTP report submitted in partial fulfillment of the requirements for the Degree of B.Tech. in Computer Science & Engineering on 18 April 2017.

**[4]** Anil K. Jain, Kai Cao and Sunpreet S. Arora, "Recognizing Infants and Toddlers Using Fingerprints: Increasing the Vaccination Coverage", International Joint conference on Biometrics (IJCB), 29spt-2oct 2014, Clearwater, florida.

**[5]** Anil K. Jain, Sunpreet S. Arora, Lacey Best-Rowden and Kai Cao, "Biometrics for Child Vaccination and Welfare: Persistence of Fingerprint Recognition for Infants and Toddlers", MSU technical report, 15 April 2015.

**[6]** Anil K. Jain, Sunpreet S. Arora, Lacey Best-Rowden, Kai Cao1, Prem S. Sudhish, Anjoo Bhatnagar, and Yoshinori Koda, "Giving Infants an Identity: Fingerprint Sensing and Recognition", 8th international conference on information and communication technologies and development (ICTD), Ann Arbor, Michigan, 2016.

**[7]** Bharadwaj, S., Bhatt, H. S., Singh, R., Vatsa, M., And Singh, S. K. Face recognition for newborns: A preliminary study. In Biometrics: Theory Applications and Systems (BTAS), 2010 Fourth IEEE International Conference on (2010), IEEE, pp. 1–6.

**[8]** Weingaertner, D., Bellon, O. R. P., Silva, L., And Cat, M. N. Newborn's Biometric Identification: Can It Be Done? In Visapp (1) (2008), Pp. 200–205.

**[9]** Francis Galton, "Finger prints of young children", Report of the British Association for the Advancement of Science 69: 868-9, 1899.

**[10]** Anil K. Jain, Sunpreet S. Arora, Kai Cao, Lacey Best-Rowden, and Anjoo Bhatnagar, "Fingerprint Recognition of Young Children", Ieee Transactions On Information Forensics And Security, December 2016.