

Infants and Toddlers Biometric Recognition: A Review

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Abstract- Infants that is newborn babies and toddlers constitute the 11% of population in India. Security and healthcare of them plays important role worldwide. Illegal adoption, swapping of newborns, abduction from hospitals, mixing and drug delivery are the global challenges faced by this community. In India AADHAAR card of toddlers is dependent on the biometrics of their parents. Biometric based recognition of infants and toddlers can play a vital role to minimize these problems. Adult recognition using biometric is already reached its matured stage but meager amount of work has been done for infants and toddlers biometric recognition. Biometric recognition of infants and toddlers itself have many challenges like database collection, changes in biometrics like face over the period of time, rigidity of parents for giving the details of their ward. This paper presents a detail review on different biometrics and their challenges for infants and toddlers. Till date the efficiency of the biometric algorithms for infants and toddlers is not up to the mark and has to travel a long path to reach the mark. In depth research is required to evaluate the efficiency of the biometric recognition system for infants and toddlers. In the literature maximum recognition rate achieved is 98 % for the database of 101 newborns.

Keywords- *infants, toddlers, biometric, recognition rate.*

I. INTRODUCTION

Missing, swapping, mixing and illegal adoption of newborns is a global challenge. The UNICEF estimates that around the world, an average of 3,53,000 babies are born each day. In India up to 49,481 babies take births per day [9]. At present times, there has been a rising need to identify individuals uniquely through modalities that are invariant to age, gender and time. Biometric features namely face and fingerprint, iris have been used successfully to identify individuals (mainly adults) for years. It has been seen that fingerprint [4], footprint [5] and face [1] have been quite persistent in identification. Comparably lesser literary evidence is there to support the reliability of such modalities for children. In a country like India, with over 158

million [1] children between the age of 0-6 years, it is imperative to uniquely identify kids with their biometric patterns. Quick and reliable identification of children through biometric are vital in immunization drives to avoid wastage of vaccines [3] and ensure its timely administration.

The Unique Identification Scheme of India (AADHAAR) does not record the biometric details of children below the age of 5 years. Instead, the biometric details of the parents are recorded and used for identification of the kids. It is required that biometric data of children after 5 years shall be recollected to update the government records. With almost 11% population less than 5 years, this shall involve massive efforts and time. This can be prevented if this threshold age can be reduced. These necessities thus require biometric based recognition system for children (0-4 years) both for health care community and government organization.

Table 1: Problems due to non-identification of Children

Problem	Description
Missing	In India Every Day 180 children go missing and 22 in Delhi only according to RTI reply from the Delhi Police [18].
Swapping	In United States, several studies have reported that every year around 1,00,000- 5,00,000 newborn babies are switched by mistake.
Abducting	The national Center for Missing and Exploited Children, United States has reported 300 infant abductions since 1983, including 3 in 2015. Out of which 44 % were from hospitals or other health care facilities. In China about 500 babies abducted every day[18]
Illegal adoption	According to local media, more than 20 people have been arrested in connection with the illegal trafficking of babies for adoption in India and overseas.

	Investigators rescued 13 babies who had been kidnapped from mothers who had recently given birth [19].
Aadhaar card data enrolment	It is not able to record the biometric details of children below the age of 5 years.
Wastage of Vaccines	In developing countries timely child vaccination is emerging issue for HIV positive children.
Incorrect Identification	In the 34 newborns that are admitted to a neonatal intensive care unit, there is 50% chance of incorrect identification.

II. EXISTING SYSTEM

Early work in identification of children of ages less than five years dates to as early as 1899, when Galton et al. [9] recorded inked fingerprint impression of children of ages from 0 to 4.5 years. He conjectured that the minimum age for children to be identified through their fingerprints is 2.5 years. Most maternities still rely on bracelets, footprint with ink and/or stamps for this purpose. There is variety of commercially available systems for adult biometric identification but not a single biometric system in use for identification of newborn babies.



Figure 1: Present method of recognition of newborns

Problems encountered while using existing method of newborn recognition:

- Misreading infant or mother bracelet information
- Bracelets falling off the infants' ankles or wrists, which is particularly common in newborns, whose arms and legs may shrink after birth due to water loss
- Bed mix-ups, in which a child is removed for bathing or treatment and then returned to the wrong bed
- Mix-ups of babies with similar or identical names
- Misreading of sequential names or ID

- numbers
- Inadequate physical security mechanisms
- Parents who are not fluent in the staff's native language [17]

III. DIFFERENT MODALITIES FOR INFANT RECOGNITION

Different modalities are used for biometric recognition of infants and toddlers like face, fingerprint, palmprints, Ballprints, footprint, headprint, ear and iris. In this paper, author discusses about following modalities.



Figure 3. Face, iris, finger and foot modalities of infants

1. FACE

Since the children are generally in a playful mode, it leads to expression and pose variations. Though adult supervision and motivation helps in improved quality data capture, the attention span of young children is very limited and therefore, patience during data collection is very important. Thus, only expression variation is allowed during the frontal face acquisition. If any other variations such as pose, illumination, or blurriness are observed by visual inspection of captured images, the image is re-acquired. In terms of the acquisition, around 20 seconds are required for each sample [6].

There are some applications, where only the face images of child are available, so face is the first modality under consideration. Samarth Bharadwaj et al. considering the non-intrusive nature of face biometrics, there research explores the possibility of using face recognition for determining the identity of new-borns. The asymmetric development of newborn faces results in a unique craniofacial structure that is not proportionally equivalent to a miniature adult face. They propose an autoencoder based feature

representation followed by problem specific distance metric learning via one shot similarity with 1-class-online SVM.

They presented a learning based encoding and distance metric approach for the problem of newborn face recognition. He combines deep learning based feature encoding scheme with a learning based distance metric to improve the performance of face recognition [1].

2. FINGERPRINT

Biological evidence, on the other hand, suggests that fingerprints are fully formed by the sixth month of fetal life and are physiologically present on human fingers at birth [10]. Y. Koda et al. captured fingerprint of a 6 hours old child using the custom 1,270 ppi fingerprint reader designed by NEC (3) the captured left thumb print image with annotated features (ridges and valleys, core, minutiae, and pores)[11], suggested that :

- (i) Design of a compact, comfortable, high-resolution (>1,000 ppi) fingerprint reader is needed.
- (ii) Image enhancement algorithms to improve quality of infant fingerprint images.
- (iii) Longitudinal infant fingerprint data collection is needed to evaluate identification accuracy over time.

According to Biometric Market Report by International Biometric Group, fingerprint is the most frequently used modality. Further fingerprint capturing requires relatively moderate cooperation of children. Preprocessing consist of two steps: An interpolation (to resize the fingerprints to an adult size and Segmentation (to reduce errors on minutia extraction) bi-cubic obtains the better result. Author captured 45000 infants fingerprint from an on production civilian database in Uruguay country by 500 dpi commercial scanner. By applying the correct interpolation factor improves the result. Good results were obtained in children older than six months using 1270 dpi scanner. TAR 90.65 % for five years old and TAR 81.42 % for one year old database. Fingerprint can be used to identify children starting from one year old.

3. FOOTPRINT

As stated previously, offline foot printing cannot satisfy the demanding for fast and reliable newborn personal authentication because of use of inadequate materials such as ink, paper and cylinder. Untrained

personal for footprint acquisition; Baby's skin covered with an oily substance is also one obstacle. Reduced thickness of the newborn epidermis, easily deforming the ridges upon contact and filling the valleys between ridges with ink. Reduced size of the newborns ridges, which are three to five times smaller than on adults [27] are the problems under consideration.

Footprint is the third modality we can consider, Wei Jia et al. proposed a novel online newborn personal authentication. They developed pre-processing methods for orientation and scale normalization of footprints [2]. Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA) and their improved version 2DLDA is matrix based version of LDA, Nearest neighbor rule is used for classification. They collected own database of 1968 images from 101 newborns' feet. About 19 to 20 images are collected from each foot. Database is collected from Anhui Province Hospital, China with digital camera Cannon Powershot SX110IS of resolution less than 100 dpi. 2DLDA achieves best recognition rate of 98.04 % compared with traditional offline footprint scheme. Author emphasis on further improvement in recognition performance is needed.

4. IRIS

Iris sensor requires participant cooperation; however, due to the inquisitive nature of young children, capturing good images is a challenge. They need constant adult supervision to be motivated to look inside the camera and not blink or move their eyes for a couple of seconds. We observe that due to the sudden eye or head movement, image capture require more time as sensor in-built quality threshold prohibits to capture poor quality [6].

RESULT AND DISCUSSION

Among all nonintrusive biometrics modalities footprint has the good recognition rate than face and finger. Though the scanning area of foot is larger as compared to finger.

As discussed in paper iris is not a suitable modality especially for infants as sudden exposer of flash light may damage their eyes while capturing the image. Compared with foot and finger face is having least recognition rate as infant face is subjected to continuous change.

Over the last decades, the idea of fusing different biometric modalities to make recognition more fool-proof and accurate has been widely explored. It is reported that a multi-modal system combining fingerprint, face can perform better system based on individual modalities. However, the

performance of multi-modal system for children is yet unexplored.

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