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Soft-Biometric in Recognition of New Born?

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***Abstract:** Most of the biometric research being done is for adults and the identification accuracy of new born are least reported in the literatures. In this paper we propose a novel biometric identification method for new born babies using their face and soft biometrics. Accurate patient identification (ID) is essential for patient safety, especially with our smallest and most vulnerable podiatric patients. The main contribution of the research are (a) the preparation of face and soft biometric database of new born. (b)Testing the algorithm for identification of 221 new born. The combined use of all the four soft biometric traits results in an improvement of approximately 6% over the primary biometric system.*

***Keywords:** Face, Soft-biometric, New born, Recognition.*

I. INTRODUCTION

How can the parent be sure that their infant will not be mixed up in hospital? The question is unavoidable and none should be answered with greater care, sympathy and understanding than this of the incoming maternity patient. The care with which it is answered, and the technique of the identification procedure explained, hangs the peace of mind of the parents until such time as the infant shows unmistakable evidences of its parentage. The security of maternity ward is of prime concern not only to medical fraternity but also to the parents worldwide. The problem of missing children is a very serious issue throughout the world and seeing the importance of this issue, May 25 is observed as National Missing Children's Day since it was first proclaimed by President Ronald Reagan in 1983. When confronted with baby swapping or abduction, many parents fear that they can do nothing to prevent this tragedy. In developing countries, this problem is more challenging because of overcrowding and scarcity of medical facilities in maternity ward. Every year around 1, 00,000 to 5, 00,000 infants in United States are exchanged (swapped) by mistake, or one out of every eight babies born in American hospitals sent home with the wrong parents [1]. According to study [2], out of 34 infants that are admitted to a neonatal intensive care unit there are 50% chances of incorrect infant's identification only in a single day.

In real applications, the biometrics traits that are commonly used in different authentication systems are the face, fingerprint, hand geometry, palm print, signature, iris, voice etc. [3]. But most of these practical biometric systems are developed for adults only. Therefore, the challenge is to design a biometric system for infants to solve the problem of their missing and swapping, which has been less addressed in the literature as per our knowledge.

The use of identification document (ID) like bracelet and radio frequency identification (RFID) tag by hospital authorities has not solved the problem of infant swapping or mixing completely. The biometric traits like Deoxyribonucleic Acid (DNA) typing and Human Leukocyte Antigen (HLA) typing are cumbersome techniques for identifying the infants because these takes more time and higher cost involvement [3]. The most popular biometrics for adult identification i.e., fingerprints also fails because fingerprint taken within 17 months after birth of a baby are not useful for identification [4]. Due to illegibility problem, footprint of an infant cannot be a potential mark for their identification in the majority of cases [5, 6, 7, and 8]. The use of iris biometrics for infant's authentication is challenging, especially in the cases of premature birth. This is due to the fact that the infant are not able to open their eyes properly and looking into the scanning devices and touching their eyelids while collecting their iris image may harm their eyes. Further, iris patterns are only stable after two years of birth [5] and therefore it is not recommended for infants' recognition. Fields et al., [9] have studied and manually analysed the samples of ear modality of infants on a database of 206 subjects. They have concluded that ears can be used to distinguish among infants. All the literatures that are focusing the problem of authenticating infants surveyed by the authors, none of them have evaluated their performance by the automated means.

The infant's database consists of static digital images of face (Digital camera of 10 megapixel and video camera of 14 megapixels to capture the images of face) and soft biometrics data like gender, height, weight and blood group. The data base acquisition of infants took one year to complete and thus it has minor variations in pose, illumination, expression due to changes in weather conditions.

The weight of an infant is measured by digital weighting machine at the place where the infant lie while providing the primary biometric. The height can be estimated from Infantometer obtained when the infant coming for check-up. The Fig.1. displays a mechanism for capturing of the height and weight information of an infant.

Fig.1 Data acquisition device
(a) Infantometer (b) weighting machine

TABLE-I
NUMBER OF SUBJECTS 210

Session	Face
First (Within 4 hours after birth)	Subject x Images
	210 x 5
Second (Normal Birth, after 20 hours)	Subject x Images
	120 x 5
Second (Scissoring, after 72 hours)	Subject x Images
	85 x 5

The database of each subject is prepared in two different sessions. In the first session the set of images is collected within four hours of birth of a child and in the second session data collection of infant is depends on the type of birth. For example, if the baby born under normal condition then data collection of infant after 20 hours otherwise in scissoring condition data is collected after 70 hours of the birth of infant.

The database statistics of all characteristics and acquisition session of infant is shown in TABLE-I. These images are captured without imposing any constraint on the infant or their surroundings. Hence collected database is combination of pose, expression and certain illumination variations due to the infant's movement, some instances of motion blurriness also present in the infant database.

II. Literary Review

The most popular biometrics for adult identification i.e., fingerprints also fails because fingerprint taken within 17 months after birth of a baby are not useful for identification. Due to illegibility problem, footprint of an infant cannot be a potential mark for their identification in the majority of cases. The use of identification document (ID) like bracelet and radio frequency identification (RFID) tag by hospital authorities has not solved the problem of infant swapping or mixing completely.

I. DATABASE DESCRIPTION OF NEWBORN

A. Face

The important covariates of face recognition are illumination, image quality, expression, pose, aging, and disguise. In case of new born, the challenges of aging and disguise are not manifested. The most distinguishing covariates between adult face and infant face are expression.

Facial expression influences the apparent geometrical shape and position of the facial feature, the influence on recognition may be more for geometry based methods than for holistic methods.

Fig. 2. Sample face Images of Infant from the Database

TABLE-II DATABASE STATISTICS OF SOFT BIOMETRICS

Height	40cm to 45 cm	46cm to 50 cm	more than 51 cm
	50	130	30
Weight	1500gm to 2500 gm.	2501gm to 4000 gm.	more than 4001gm
	50	130	30

Gender Distribution	**Male**				**Female**			
	70				140			
Blood Group	A+	A-	B+	B-	AB+	AB-	O+	O-
	32	21	30	20	25	18	58	6

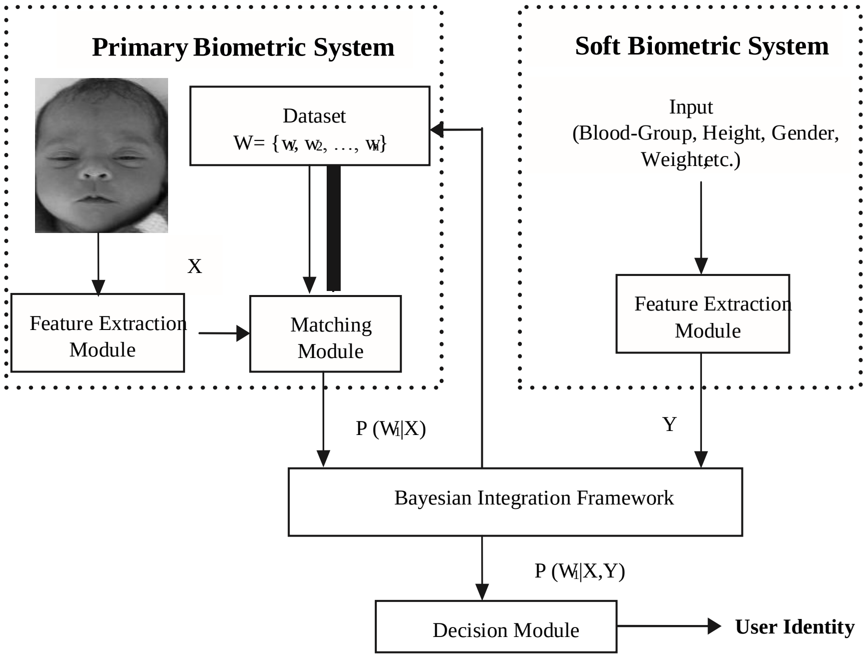
III. FRAME WORK FOR FUSION OF FACE AND SOFT BIOMETRIC INFORMATION

The face database contains variations in images collected in different pose, illumination, expression and variations in quality due to motion blurriness. Facial images are grouped according to variations mentioned above to solve the problem of face recognition in new born as shown in Fig2.

Infants are presumed to exert no voluntary control over their expressive behaviour (e.g., they do not adhere to cultural display rules), due to this they are highly no cooperative users of biometrics and to capture their frontal face image is big challenge. Therefore, the images had shown in Fig.2 display the variation in their pose, illumination and expression which can be used to test the algorithms for recognition of infants with pose, illumination and expression variations.

B. Soft biometrics

Soft Biometrics characteristics like gender, blood group, age, height, weight and head print are not unique and reliable but they provide some useful information about the individual and these are referred as soft biometric trait and these trait compliment the primary biometric trait [10, 11, 12]. Soft biometric traits help in filtering large databases by reducing the number of search for each query. In case of infants we have collected gender, height, weight, blood group. The format of soft biometric data is shown in the TABLE-II.



In the proposed framework, the biometric recognition system is divided into two subsystems. The two subsystems are the primary biometric system which consist of face and the secondary biometric system consisting of soft biometric traits like height, weight, gender and blood-group. Fig. 3 shows the architecture of a personal recognition system that makes use of both face and soft biometric measurements [13].

IV. EXPERIMENTAL WORK

In order to proof the usefulness and validity of our database we have selected face and soft biometric data to demonstrate the accuracy of identification of infant.

It is observed that infants have rich skin texture and distinct facial features. Further, it is difficult to restrict pose and expression variations of babies. The hypothesis is that for babies, information content present in the image changes with expression variations. In order to achieve our goal of applying face recognition to infants, we evaluate well-known, classical algorithms: PCA, ICA, LDA, and LBP.

To identify the infant face, four algorithms have been selected for implementation

1. Principal Component Analysis (PCA) [14].
2. Independent Component Analysis (ICA) [15].
3. Linear Discriminant Analysis (LDA) [16].
4. Local Binary Pattern (LBP) [17, 18].

V. RESULTS

We have manually detected faces for solving the face detection errors problem and used geometric normalization (or affine transformation) for face alignment. In our infant database most of the time eyes of infant are closed so that avoiding errors set the distance of inter eye to be 100 pixels.

For evaluating performance the infant database is partitioned into training and testing/ probe. We have collected 10 images of each infant, out of 10 images 6 images of each infant is randomly selected for training/gallery database (total of 900 images) and the remaining 4 images of each infant is selected for testing/probe database (total 600 images).

Evaluation process is performed five times for checking validation and computed rank-1 identification accuracies. The overall performance evaluation of all the four algorithms is compared which is shown in the TABLE-IV. From the TABLE-IV and Fig.4, it is observed that the identification accuracy of LBP is 82.76% at Rank-I.

TABLE-III
IDENTIFICATION ACCURACY OF THE INFANT DATABASE

Procedure	**PCA**	**ICA**	**LDA**	**LBP**
Identification Accuracy (Rank-1)	74.34	78.12	80.15	82.76

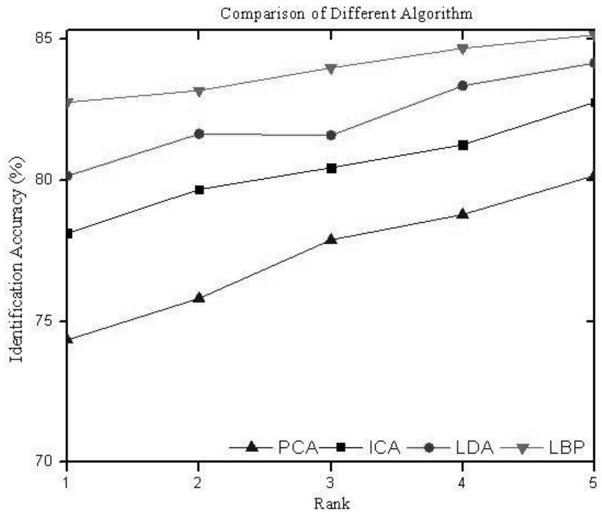


Fig. 4. CMC for Face Recognition Algorithm.

VI. PERFORMANCE GAIN USING SOFT BIOMETRICS

In our experiments we have selected soft biometric traits such as gender, blood group, weight, and height information of the user in addition to the face biometric identifiers.

Let $P(\omega_i|s)$ be the posterior probability (Face) that the user is infant $\square_i$ $\square$given the primary biometric score‘s’ of the test user. Let $y_i=(G_i,B_i,W_i,H_i)$ is the soft biometric feature vector corresponding to the identity claimed by the user $\square_i$, where G_i,B_i,W_i and H_i are the true values of gender, blood group, weight, and height of $\square_i$. Let $y^*=G^*;B^*;W^*;H^*)$ is the soft biometric feature vector of the observed test user, where G^* is the observed gender, B^* is the observed blood group, W^* is the observed weight, and H^* *is* the observed height. Finally the score after considering the observed soft biometric characteristics is computed as Fig.5 shows the Cumulative Match Characteristic (CMC) of the face biometric system operating in the identification mode, and the improvement in performance achieved after the utilization of soft biometric information. The weights assigned to the primary and soft biometric traits were selected experimentally such that the performance gain is maximized. However, no formal procedure was used and an exhaustive search of all possible sets of weights was not attempted. The use of blood-group, height, weight and gender information along with the face leads to an improvement of 1% in the rank one performance as shown in Fig. 5(a), 5(b), 5(c) and Fig. 5(d) respectively. From 5(b), 5(c) and Fig. 5(d), we can observe that the blood-group information of the infant is more discriminative than gender and leads to a 1.5% improvement in the rank one performance. The combined use of all the four soft biometric traits results in an improvement of approximately 6% over the primary biometric system as shown in Fig. 5(e).

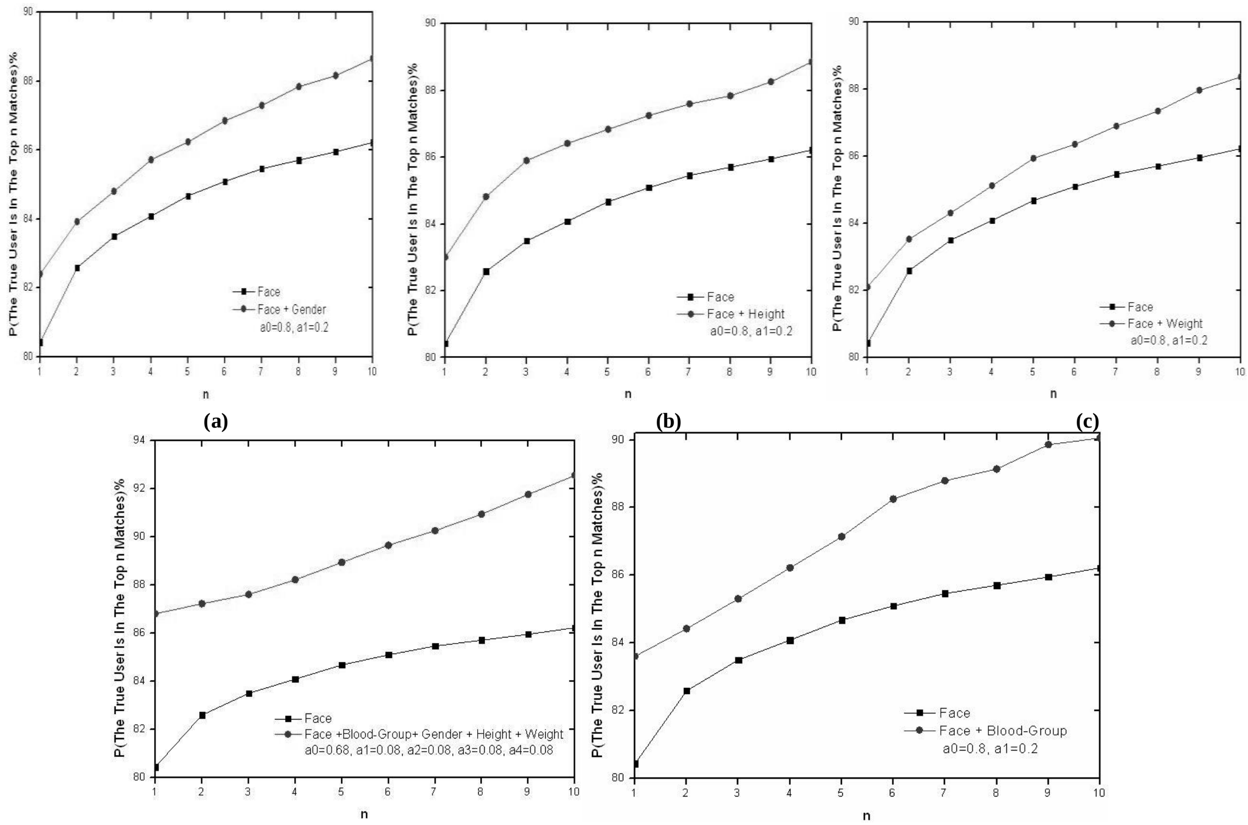
The gender information did not provide any improvement in the performance of a face recognition system. This may be due to the fact that the gender classifiers and the face recognition system use the same representation. However, the height and weight information is independent of the facial features and, hence, it leads to an improvement of 3.1%, 2.1% respectively in the face recognition performance. The failure of the gender information to improve the face recognition performance establishes that fact that soft biometric traits would help in recognition only if the identity information provided by them is complementary to that of the primary biometric identifier.

TABLE-III

IDENTIFICATION ACCURACY OF THE INFANT DATABASE

Procedure	F	F + G	F + H	F +W	F+ B	F+G+H+W+B
Identification Accuracy (Rank-1)	80.42	82.40	83.12	82.10	83.60	86.80

Where F=Face, G=Gender, H=Height, W=Weight, B=Blood-group



(d) (e)

Fig.5. Improvement in the performance of a unimodal (face) system after addition of soft biometric traits, (a) Face with Gender, b) Face with Height, c) Face with Weight, d) Face with Blood-Group and e) Face with Blood-Group ,Gender, Height and Weight.

VII. DISCUSSION

Mixing and kidnapping of infant is a strong negative response, most of the time they things parents fear the most things which seem difficult to control or stop. If they confronted with these situations, many parents fear that there is nothing they can do to prevent this tragedy. There is a lot of justification for recognition of infants using biometrics to mitigate the problem of mixing, switching, abduction and some of the biometric traits collected in the prepared database are justified for only some limited time duration.

In certain application where face image is occluded or is captured in off frontal pose, due to movement of infant some instances of motion blurriness also present in face image. Soft biometrics can provide more valuable information for face matching or retrieval. It is also useful to differentiate identical twins whose global facial appearances are very similar. The similarity found from soft biometrics can also useful as a source of evidence in court of law because they are most descriptive than the numerical matching scores which is generated by a traditional face images. However, biometric database collection is a time and resources consuming process, especially in the case of infants (non cooperative users) multimodal database.

The prepared database giving a framework to implement secure methods or techniques for solving the infants mixing, switching, abduction and illegal adoption problem also facilitates to the authorities for tracking of the missing infant based on his/her biometric features. This would be also lessen the fear of infants and their parents might not be swapped and that they are the legitimate parents of their own baby.

Our proposed model demonstrated that the utilization of ancillary user information like gender, height, weight and blood-group can improve the performance of the traditional biometric system. Although the soft biometric characteristic are not as permanent and reliable as the traditional biometric identifiers like face, they provide some information about the identity of the user that leads to higher accuracy in establishing the user identity.

VIII. CONCLUSION AND FUTURE DIRECTION

The objective of this paper is to demonstrate that face and soft biometric identifiers such as height, weight, gender, and blood-group can be very useful in new born recognition. It is our assertion that face and soft biometric data can be a very promising tool for identification of new born. Although the soft biometric characteristics are not as permanent and reliable as the traditional biometric identifiers like face, they provide some information about the identity of the new born that leads to higher accuracy in establishing the user identity. The soft biometric taken together with the primary face appearance and /or multimodal biometrics, however can sometime make the difference and help to gain confidence in the recognition decision made.

Our future work will involve design and testing of more advanced algorithms for face recognition and better fusion methods to increase the identification accuracy.

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