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Identification of Identical Twins Using Multimodal Biometric

B. Lakshmi Priya
Ph.D Research Scholar,
Department of Computer Science,
Mother Teresa Women's University,
Tamilnadu, India

Dr. M. Pushpa Rani
Professor & Head
Department of Computer Science,
Mother Teresa Women's University,
Tamilnadu, India

Abstract- Biometrics is the science and technology of measuring and analyzing biological data of human body, extracting a feature set from the acquired data, and comparing this set against to the template set in the database. Reliable and accurate verification of people is extremely important in a number of business transactions as well as access to privileged information. The biometrics-based methods assume that the physical characteristics of an individual (as captured by a sensor) used for verification are sufficiently unique to distinguish one person from another. But the increase in twin births has created a requirement for biometric systems to accurately determine the identity of a person who has an identical twin. Identical twins recognition is a difficult task due to the existence of a high degree of correlation in overall facial appearance. In this paper Proposes a new concept of distinguish between identical twins using Multimodal biometric systems perform better than unimodal biometric systems and are popular even more complex also. For this researchers collected multiple biometric traits (like finger print, face, and Lip print) of 214 families of twins, the Experimental results prove to the ability of proposed method to recognize a pair of identical twins.

Keywords- Twins, Multimodal, Finger Print, Mouth Print, Face, Biometrics.

I. INTRODUCTION

A biometric identification (matching) system is an automatic pattern recognition system that recognizes a person by determining the authenticity of a specific physiological and/or behavioural characteristic (biometric) possessed by that person. Fertility treatments have resulted in an increase in the identical twin birth rate [1].The identical twin birth rate is about twice as high for women who use fertility drugs. Accurately distinguishing the identity of twins has important legal ramifications. In 1985, a woman was accused of making fraudulent money transfers from banks nationwide by simply making telephone calls. She was acquitted of those charges after claiming her sister who was her identical twin but disappeared before the trial committed the crimes. In the end, both twins were convicted. Based on an analysis of their voices, a speech scientist and voice examiner testified that both women had placed the fraudulent telephone calls [2]. In this case, being able to distinguish both twins was essential to the convictions. The recently, a rape suspect won two mistrials because there was no way of determining whether the key DNA evidence came from him or his identical twin. However, in his third trial in 2006, he was convicted after the prosecutors provided evidence that he had committed a series of sexual assaults and attempted sexual assaults with characteristics similar to the rape for which he was being tried then [3].Therefore, the failure to distinguish the twins was crucial to the charges being dropped in the first two mistrials.

The similar appearances of identical twins may also give them a greater incentive to commit fraud than average persons. Imagine a scenario where you have an identical twin brother/sister, and he/she has health insurance but you do not, and you get sick. In order to get medical treatment, the health insurance company requires health providers to establish your identity using photo identification. You could use your twin's health insurance without being noticed. But, let us suppose the health insurance company requires that you need to be identified using fingerprints (this is the case for some of the health insurance companies in Brazil); if the fingerprint recognition system can distinguish twin fingerprints, then you will not be able to get health care using your twin's name and insurance policy. The above facts and scenario indicate that the ability of biometric systems to identify identical twins is necessary. There are two types of twins: monozygotic (or identical) and dizygotic (or non-identical). Monozygotic twins are a result of a single fertilized egg that splits into two cells, each one giving origin to one individual. Dizygotic twins are a result of two different fertilized eggs. Monozygotic twins have the same deoxyribonucleic acid (DNA) and, therefore, they cannot be distinguished using DNA [4]. Thus, it is necessary to use other forms of identification for monozygotic twins. Recognition using biometric traits is now a well accepted and proven method. A biometric characteristic is a detectable biological or behavioral characteristic of an individual that is distinguishable and repeatable. Some examples include fingerprints, face, palmprints, iris, retina, and voice. A biometric system relies on the distinctiveness of the biometric characteristics to perform the recognition. While many biometric techniques are extremely accurate, some variations in sensing data, noise, etc. can cause the system performance to drop significantly. We could say it is more difficult to discriminate identical twins than unrelated persons because of their genetic similarity. Although identical twins cannot be distinguished from each other using DNA,

some of the biometric modalities, such as fingerprints, iris, and palmprints, can still be used to distinguish them [5]. Some experiments show that face and voice [6], [7] can be used to distinguish identical twins. Due to the difficulty in obtaining a large biometric database of identical twins, most experiments are performed on small databases, making the conclusions less reliable.

The rest of this paper explores the impact of identical twins on unimodal and multimodal biometric systems. In Section 2, present previous studies based on biometric twin data. In Section 3, present the biology of the three biometric characteristics that will be used in our multibiometric experiments, namely fingerprint, face, and lip print. In Section 4, Experimental results on matching individual biometric traits as well as various combinations of modalities. In Section 5, concludes the paper.

II. REVIEW OF RECENT RESEARCHERS

In order to design a robust and efficient biometric system, the system must be able to handle a variety of situations like noisy data, limitations of the sensors, environmental conditions, and the presence of identical twins. Due to the similarity of their biometric characteristics, identical twins are more likely to pose a challenge to a biometric system. Therefore, it is important to address this problem when designing a biometric system. Studies on discrimination of identical twins that have been reported in the literature are summarized below.

Daugman and Downing[8] assessed the distinctiveness of iris patterns as biometric identifiers. The authors compared unrelated irises (irises from different persons), and genetically identical irises (irises that came from the same DNA), for example pair of irises of the same person or the irises of identical twins. They observed that the iris patterns of genetically identical eyes were as uncorrelated as the patterns of unrelated eyes. For example, the similarity of the six pairwise comparisons they performed between identical twins showed the same mean as for eyes that were not genetically related.In a study of identical twins' palmprints, Kong *et al,[5]* used 1,028 palmprint images from 53 pairs of identical twins. They performed two different twin matches. In the first experiment, they matched the palmprints of identical twins, which they called real twin match. In the second experiment, they matched the left and right palmprints of the same person, which they called virtual twin match. Note that in both the experiments the palmprints shared the same genetic information. The authors observed that while these genetically equivalent palmprints have correlated features, they can still be distinguished based on non-genetically related information.

The above observation concerning palmprints is also true for fingerprints, as a study based on 94 pairs of identical twin fingerprints has shown [4] .Fingerprint verification systems can be used to distinguish identical twins, even though their fingerprints are generally more correlated than fingerprints coming from two genetically unrelated persons. As an example, at a False Rejection Rate (FRR) of 1.05%, the twin-twin matching had a False Acceptance Rate (FAR) of 8.51%, while the twin-non twin matching had a FAR of 2.20%. For another threshold value (FRR of 3.49%), the twin-twin FAR dropped to 1.06% and the twin-nontwin FAR dropped to 0.29%. In another analysis of fingerprints from 66 pairs of twins[9], it was also concluded that fingerprints can be used to identify identical twins with an insignificant drop in the performance: the Equal Error Rate (EER) reportedly increased by only 1-2% compared to nontwin impostor matchings. The authors also extended their studies to assess the similarities among families of nontwins (52 families of four persons | parents and two children). They observed that the largest similarity occurred between identical twins, followed by between two siblings, between parents and their children, and between unrelated persons.

Srihari *et al.* analyzed the similarity between twins' fingerprints in a study using fingerprint images from 298 pairs of twins[10]. The authors analyzed this similarity based on Level 1 and Level 2 features (that is, pattern of the ridge flow, and minutiae, respectively). With the level 1 features, they observed that fingers with the same label twins' fingers occurred approximately 55% of the time for twins and approximately 32% for non-twins, which means twins' fingers are much more likely to have the same pattern type than non-twins' fingers. With the level 2 features, they concluded that the similarity between twin fingers is higher than between two arbitrary fingers (with identical twin fingers similarity being not significantly different from fraternal one), but twins can still be distinguished using fingerprints.

Although it is believed that face and voice, along with hand geometry, are more difficult to distinguish between identical twins[4],some researchers have obtained encouraging results using face and voice to distinguish monozygotic twins[6][7][11]. A verification experiment with 10 sets of identical twins was performed using a 2D face recognition system; the experiment consisted of enrolling one of the twins, and asking the other to try to log into the system. On this small database, the rejection threshold was always satisfied, leading to a rejection of all the impostor twins[6].

Another face recognition experiment for twins was based on 3D facial images[11]. The recognition task was to distinguish between two identical twins; the authors tested three different algorithms: a 2D algorithm based on eigenfaces, a 3D algorithm based on rigid surface, and another 3D algorithm based on canonical forms. The test consisted of enrolling one of the twins and matching the enrolled subject to the other twin. All the other subjects served as impostors. For the first algorithm (2D eigenfaces), the False Acceptance Rate (FAR) was 29.41% when enrolling the first twin and 25% when enrolling the other. In the second experiment, the FAR was 17.64% and 0, respectively, while for the third algorithm perfect matchings were obtained. According to the Web site Digital World Tokyo[12],the Japanese company Sagawa Advance has invented an infra-red based face recognition technology that is able to distinguish identical twins.

Ariyaeeinia *et al.[7]* performed recognition experiments using speech data from 49 pairs of identical twins. The authors performed basically two different experiments: a general experiment, in which any two persons in the dataset were considered impostors, and the twin experiment, in which the impostor tests consisted of the tests between a person and his/her twin. The Equal Error Rate reported was 1.0% for the twin experiment using short test data (each person

saying his/her date of birth), and 0.5% for the general configuration. Other authors have tried to distinguish identical twins based on voice in a multilingual environment[13].Using a database of 12 twins, Patil and Basu reported the highest success rate as being 100% for a particular size (in seconds) of the training speech, and particular size (in seconds) of the test speech. They also observed that the majority of errors were due to matching the actual speaker with his/her twin brother/sister.

However, in many previous studies, the identical twin biometric databases are very small and in-house biometric matchers instead of the state-of-the-art matchers are used. Moreover, no study has been conducted to compare and fuse multiple biometric traits of identical twins.

III. MULTIBIOMETRICS

A Multibiometric system uses multiple sources of biometric information in order to recognize an individual. In the next subsections, these researchers focus attention on the distinctiveness of fingerprints, face, and Mouth print for identical twins. These three modalities will be used in this research multibiometric experiment. A more detailed representation of the proposed system is shown on Figure1.

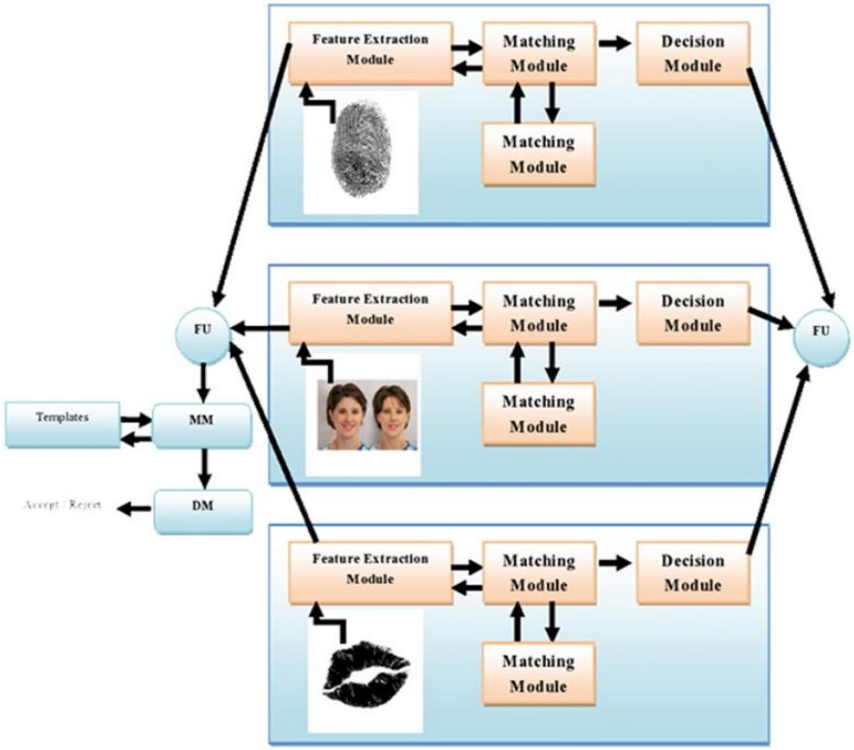

Fig.1 Block Diagram of the proposed system

A. Fingerprint Recognition

A Fingerprint is the impression of the friction skin on a finger. Figure 1 shows images of fingerprint recognition from the twin dataset. The individual characteristics of friction ridge skin are determined during fetal development. Their formation is similar to the formation of blood vessels or capillaries during the growth of the fetus in the uterus. The fingerprint formation starts at approximately 6 or 7 weeks of gestational age and it is due to the flow of amniotic fluids in a micro-environment [14]. A minor change in this flow and in the position of the fetus in the uterus cause the minute skin structures around palm or finger tips to differentiate. Friction ridge skin can be distinguished from the skin of the rest of the body due to a variety of factors, such as the presence of raised ridges, increased sensory abilities, absence of hair and sebaceous glands, and a thicker and more complex epidermis. Friction ridges are related to grasping and gripping, which explains their presence in our hands and feet.

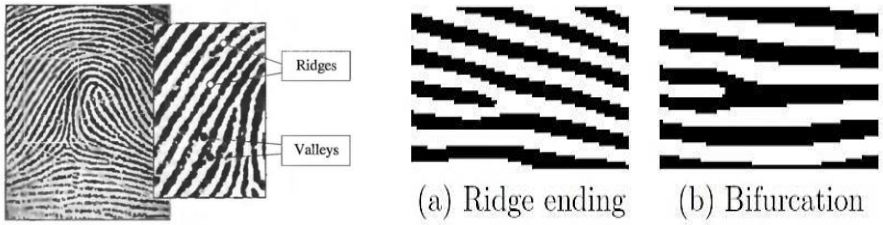

Fig. 2 Images of Fingerprint Recognition

B. Face Recognition

Face is composed of the skull characteristics and the musculature and associated soft tissue. To study the variation among human faces it is necessary to study these structures. The facial skeleton serves as the bony framework for the

mimetic musculature. Since these muscles are stretched across the facial skeleton like a mask, the variation in facial appearance is caused mostly because of the form of the facial bones. There are a number of factors that influence the performance of a facial recognition system. Besides those already cited above, there are differences in pose, illumination, expression, occlusion, accessories like glasses, weight changes, hair style changes, etc. All these variations make facial recognition systems not as accurate as some other biometrics, like fingerprints. Identical twins present a very difficult situation for face recognition systems, since they are usually very similar in facial appearance. Figure 3 shows some images from the twin dataset.

Fig. 3 Sample images of twin face Database

C. Mouth Print Recognition

To determining the Mouth Print shown in Figure 4, have consists of the following parts.

1) Image Normalization: The normalization procedure allows standardizing the Mouth print images involving horizontal alignment and separation into upper and lower lip.

2) Mouth Pattern Extraction: The Mouth pattern extraction allows separating lines forming the lip pattern from their background.

3) Feature Extraction: The main goal of the features extraction is to convert lip pattern image into projection (specialized histogram) which can be then compared using the proposed system algorithm.

Fig. 4 Twins Mouth Print images

IV. EXPERIMENT AND RESULTS

In this section the performance of the proposed multibiometric recognition is tested on a real time database consisting of 214 pair of identical twins from whom the face, fingerprint and Mouth Print images of the persons are collected. The images are acquired in a resolution of 256x256 sizes. We have implemented our multibiometric system in MATLAB 2013 on a intel core i3 Windows 8 workstation. To build our virtual multimodal database, these researchers have chosen 100 images. Face images are randomly sampled as training samples, and the remaining are left as test samples. The technique is also applied for fingerprint and Lip Print databases to collect training samples. Then, each sample of the face database is randomly combined with one sample of the fingerprint database and one sample of the Mounth Print database. The performance of a biometric system can be shown as a Receiver Operating Characteristic (ROC) curve that plots the Genuine Accept Rate against the False Accept Rate (FAR) at different thresholds on the matching score. Fig. 5 shows the performance of the hybrid approach presented here. We compare this performance with other approaches that does not utilize texture information for representing the fingerprint. As can be seen in the graph, the proposed hybrid approach outperforms over a wide range of FAR values.

ROC Curve

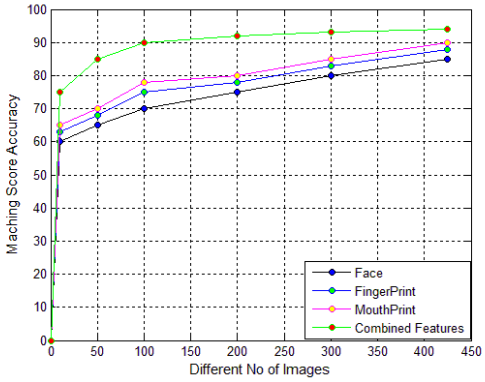

Fig 5. Receiver Operating Characteristics Curve

The results obtained using various multibiometric systems were analyzed and the area under the ROC curve for each method using Real Time database Matching Score are shown in Table 1. and it shows the area under the ROC curve (***Az***), Standard Deviation (*S.D*) and 95% Confidence Interval (*CI*) for each classifier. Results show that high performance was obtained by the proposed scheme when compared to other multibiometric systems.

Table 1. Matching Score

Modality	Matching Score
Finger Print	93.62
Face	91.27
Mouth Print	95.20
Combined Features	93.36

V. CONCLUSION

This paper has presented a multimodal approach and comparison of three approaches in implementing a biometric system. Using a multimodal database we have investigated the relative merits of adopting a single classifier approach, an approach which uses a multimodal classifier configuration operating on a single modality and, finally, a multimodal biometric solution which combines different biometric samples in providing an identification decision. Our study has provided quantitative data to demonstrate the relative performance levels, in terms of ROC curve, attainable in each case, and we have shown how multimodal biometric solutions, while offering other additional advantages where appropriate, provide only modest improvements over an approach based on a multimodal classifier approach and a single modality, bringing some potentially significant benefits in terms of usability.

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