# Identification of Identical Twins Using Fusion of Various Facial Feature Extractors

**R. Prema[1], Dr. P. Shanmugapriya[2]**
[1]Assistant Professor and Research scholar, Dept of CSE
[2]Associate Professor, Dept of CSE
[1, 2] SCSVMV University, Kanchipuram,Tamil Nadu, India

***Abstract-*** *Distinguishing identical twins using their face images is a challenge in biometrics. The goal of this study is to construct a biometric system that is able to give the correct matching decision for the recognition of identical twins. We propose a method that uses feature-level fusion, score-level fusion, and decision-level fusion with principal component analysis, histogram of oriented gradients, and local binary patterns feature extractors. In the experiments, face images of identical twins from ND-TWINS-2009-2010 database were used. The results show that the proposed method is better than the state-of-the-art methods for distinguishing identical twins. Variations in illumination, expression, gender, and age of identical twins' faces were also considered in this study. The experimental results of all variation cases demonstrated that the most effective method to distinguish identical twins is the proposed method compared to the other approaches implemented in this study. The lowest equal error rates of identical twins recognition that are achieved using the proposed method are 2.07% for natural expression, 0.0% for smiling expression, and 2.2% for controlled illumination compared to 4.5, 4.2, and 4.7% equal error rates of the best state-of-the-art algorithm under the same conditions. Additionally, the proposed method is compared with the other methods for non-twins using the same database and standard FERET subsets. The results achieved by the proposed method for non-twins identification are also better than all the other methods under expression, illumination, and aging variations.the image and encrypt the data. Dawson says, "If images are high-quality and components of a face are broken down into a template, it is possible to see minute differences between identical twins."*

## I. INTRODUCTION

There is a caveat, however; while it is possible to match an image of an identical twin against a small database of images, as the database grows, performance deteriorates as there is a greater chance that there are other facial images with similar features. Says Dawson, "If an image group is large, there is an impact on the performance of any identification."
Another approach to facial recognition uses spatial orientation of facial features. For example, a picture of eyes and everything around them can be transformed into spatial frequency (the level of detail present per degree of visual angle). This is the basis of linear discriminant analysis, based on an idea suggested by Sir Ronald A. Fisher in 1936 and used to find the subspace representation of facial images. Again, using this technique it may be possible to distinguish identical twins.

Arun Ross, professor of computer science and engineering at Michigan State University, breaks down facial recognition into three levels. Level one includes the shape of a face; level two includes specific features such as eyes, nose, and mouth, and level three incorporates more precise detail, such as freckles, scars, or tattoos. Says Ross, "Using multiple feature sets and level three features, identical twins can be identified, but systems will still make errors."

Having twice visited the Twins Day Festival in Twinsburg, OH, the largest annual gathering of twins in the world, Kevin Bowyer, Schubmehl-Prein professor in the department of Computer Science and Engineering at the University of Notre Dame, Indiana, collected facial, fingerprint, and iris data with the goal of distinguishing identical twins.

Like his peers, Bowyer says high-quality images and high-performing algorithms can go some way to distinguishing identical twins, although the algorithms need to be able to register fine details that are reliably different. The challenge here is transient detail, which Bower says can include such minute detail as scabs on the face, which can be covered up. In these types of cases, Bowyer says it is hard to catch twins substituting for each other. "Facial recognition most probably won't work if identical twins set out to defeat the system."

Facial recognition systems often use several techniques and fuse the results. For example, machine learning and neural networks allow systems to look at full images and subsets of data included in templates. Similarly, several algorithms can be agglomerated to create datasets of certain aspects of a face and, over time, learn what features to extract to support accurate facial recognition.

Biometric fusion can be implemented in two different modes, either prior to matching process or after matching process. In this study, fusion techniques from each biometric fusion mode were used such as feature-level, score-level, and decision-level fusion techniques. Feature-level fusion represents biometric fusion prior to matching. However, score-level and decision-level fusion are methods of biometric fusion techniques that are implemented after a matching process. There are many biometric systems employing fusion of different levels

## II. FEATURE-LEVEL FUSION

Consolidating two or more different biometric feature sets of the same user in order to form them as one feature set is a definition of feature- or representation-level fusion. Feature-level fusion can be classified into two different classes such as homogenous and heterogeneous feature fusion. A homogeneous feature fusion scheme is used when the feature sets to be combined are obtained by applying the same feature extraction algorithm to multiple samples of the same biometric trait (e.g., minutia sets from two impressions of the same finger). This approach is applicable to multi-sample and multi-sensor systems. Heterogeneous feature fusion techniques are required if the component feature sets originate from different feature extraction algorithms or from samples of different biometric traits (or different instances of the same trait).

A heterogeneous feature fusion technique is used in this paper by combining different feature sets which are extracted by PCA, HOG, and LBP methods. The first case is done by consolidating the extracted feature sets of PCA, HOG, and LBP, as one feature set, while the fusion in the second case is implemented by using only the feature sets which are extracted by HOG and LBP.

## III. SCORE-LEVEL FUSION

When a final recognition decision can be acquired by combining two or more match scores of different biometric matchers, fusion is said to be done at the score-level. After capturing the raw data from sensors and extracting feature vectors, the next level of fusion is based on match scores. It is relatively easy to access and combine the scores generated by different biometric matchers; as a result, score-level fusion is the most commonly used methods in multibiometric systems. There are many types of score-level fusion such as likelihood-ratio-based fusion and transformation-based fusion. In this paper, transformation-based fusion (sum rule) was used.

## IV. DECISION-LEVEL FUSION

In a multibiometric system, fusion is carried out at decision level when only the decision outputs by the individual biometric matchers are available. The decision-level fusion rules such as "AND" and "OR" rules, majority voting, weighted majority voting, Bayesian decision fusion, the Dempster-Shafer theory of evidence, and behavior knowledge space are used to integrate the multiple decisions to produce the final decision.

The main steps of the proposed method are presented below:

1. Apply feature-level and score-level fusion using HOG and LBP in addition to decision-level fusion using PCA, HOG, and LBP.
2. Partial decisions from each level of fusion will be acquired as follows: If (Partial Decision=Genuine), then Ri=1, else (Partial Decision=Impostor) Ri=0.
3. In both decision cases, either genuine or impostor, the partial decision will present the recognized ID of the individual.
4. If two or more of the fusion levels recognize the input image as genuine based on the claimed ID, the whole system will recognize the user as genuine.
5. In the case of only one fusion level recognizes the input image as genuine, the system will check the recognized IDs of other algorithms. If they are not the same, the whole system will recognize the user as genuine; otherwise, the system will recognize the user as impostor. Table 1 clarifies this step.

## V. CONCLUSION

A novel method is proposed for the solution of distinguishing identical twins by using facial images. The proposed method uses feature-level fusion, score-level fusion, and decision-level fusion with three feature extraction approaches. PCA, HOG, and LBP are implemented as feature extractors and matching is performed using KNN. Various experiments are conducted using ND-TWINS-2009-2010 and standard FERET Datasets. The experiments that use ND-Twins-2009-2010 database are performed under different illumination, expression, age, and gender conditions using samples of identical twins and non-twins separately. Additionally, the performance of the proposed method is measured using standard FERET Dataset of non-twins' faces under different expression, illumination, and aging conditions. Experiments show that the recognition of identical twins is harder when the conditions of capturing samples are different. Consequently, the degree of difference between images is lower when both training and test samples are acquired under the same conditions such as uniform lighting and natural expression. Results are not significantly affected by variation in age and gender. In addition, the high similarity between identical twins significantly affects the performance of any recognition system compared with the non-twins case. The proposed method is compared with four unimodal and five multimodal systems that are conducted in this work in addition to seven state-of-the-art algorithms.

## REFERENCES

[1] AK Jain, AA Ross, K Nandakumarr, *Introduction to biometrics* (Springer Science Business Media, New York, 2011), pp. 978–0387773254CrossRefGoogle Scholar

[2] A Bolotnikova, H Demirel, G Anbarjafari, Real-time ensemble based face recognition system for NAO humanoids using local binary pattern. Analog Integr. Circ. Sig. Process.**92**(3), 1–9 (2017).CrossRefGoogle Scholar

[3] I Lüsi, JCJ Junior, J Gorbova, Baro, Ẋ, S Escalera, H Demirel, J Allik, C Ozcinar, G Anbarjafari, in *Joint challenge on dominant and complementary emotion recognition using micro emotion features and head-pose estimation: databases*. Automatic Face & Gesture Recognition (FG 2017), 2017 12th IEEE International Conference On (IEEE, Washington, 2017), pp. 809–813.Google Scholar

[4] G Anbarjafari, Face recognition using color local binary pattern from mutually independent color channels. EURASIP J. Image Video Process. **2013**(1), 6 (2013).CrossRefGoogle Scholar

[5] P Phillips, P Flynn, K Bowyer, R Bruegge, P Grother, G Quinn, M Pruitt, in *Proc. IEEE Conf. Autom. Face Gesture Recognit. Workshops*. Distinguishing identical twins by face recognition (IEEE, Santa Barbara, 2011), pp. 185–192. doi:10.1109/FG.2011.5771395.Google Scholar

[6] KI Kim, K Jung, HJ Kim, Face recognition using kernel principal component analysis. IEEE Signal Proc. Lett. **9**(2), 40–42 (2002).CrossRefGoogle Scholar

[7] O Déniz, G Bueno, J Salido, F De la Torre, Face recognition using histograms of oriented gradients. Pattern Recogn. Lett. **32**(12), 1598–1603 (2011).CrossRefGoogle Scholar

[8] T Ahonen, A Hadid, M Pietikäinen, Face description with local binary patterns: application to face recognition. IEEE Trans. Pattern Anal. Mach. Intell. (PAMI). **28**(12), 2037–2041 (2006). doi:10.1109/TPAMI.2006.244.CrossRefzbMATHGoogle Scholar

[9] A Jain, S Prabhakar, S Pankanti, On the similarity of identical twin fingerprints. Pattern Recog. **35**(11), 2653–2663 (2002). doi:10.1016/S0031-3203(01)00218-7.CrossRefzbMATHGoogle Scholar

[10] A Ariyaeeiniaa, C Morrison, A Malegaonkara, B Black, A test of the effectiveness of speaker verification for differentiating between identical twins. Sci. Justice. **48**(4), 182–186. (2008). doi:10.1016/j.scijus.2008.02.002.