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Twin Facial Identification and Differentiation using the Viola-Jones method, PCA and ANN

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Abstract - *The person's face is a highly complicated visual object and the creation of a theoretical model for understanding it is thus very difficult. Photo-based on close twin-face recognition is a difficult challenge in computer technology. Twin Face detection and differentiation is the biggest issue faced by multifaceted graphical model design, and it is a current research topic. Traditional facial recognition program demonstrates low performance under realistic conditions in differentiating identical twins. There are several different strategies for identifying identical twins ex: Fingerprint Identification, Iris Detection, etc. Traditionally, many studies were carried out to distinguish twins and also to recognize their traits of distinction, and there were even other methods to display similarities between twins using fingerprints, speech, and iris as part of pattern recognition. Existing techniques are used to recognize twins such as fingerprinting, speech recognition, and iris. The art of identifying the difference between facial features of twins is very tricky because they display many similar characteristics such as gestures, age, hairstyle change, etc. Twin Face differentiation plays a key role in systems such as surveillance network, authentication of credit cards, identification of offenders at airports, train stations, etc. As most methods for detecting and recognizing the twin faces have been proposed, developing a computer model for a similar image database is still a difficult challenge. It's why twin facial recognition is considered a major-level function in image processing, in which strategies can be developed to produce reliable data. Artificial neural networks, and principal component analysis are a few common methods used for twin-face recognition. In this paper, we are going to use Voila-Jones, Principal Component Analysis (PCA), Euclidean Distance, and Neural Network pattern recognition techniques to differentiate between the twins.*

***Key Words*: Face recognition, Principal Component Analysis, Artificial Neural Network, Viola-Jones algorithm.**

1. INTRODUCTION

Face detection is a biggest issue faced by multifaceted graphical model design, and it is a current research topic. The art of identifying the facial features is very tricky because it displays various characteristics such as gestures, age, hairstyle change etc. Face detection plays a key role in systems such as surveillance network, authentication of credit cards, identification of offenders at airports, train stations etc. As most methods for detecting and recognizing the human face have been proposed, developing a computer model for a large database is still a difficult challenge and that differentiating twins is greater challenge. It's why facial recognition is considered a major-level function in image processing, in which strategies can be developed to produce reliable data. Artificial neural networks, Viola-Jones algorithms and principal component analysis are few common methods used for face recognition.

The approach suggested would be applied in two phases. Since the human face is identifiable in the first step by certain facial characters, the relevant features are extracted from the facial image. They then are quantized such that the face shapes these characteristics should be easy to recognize. For face detection Viola-Jones algorithm. Accurate results to differentiate twins are obtained by using the face-detected fusion of the principal components analysis algorithm and artificial neural network.

The suggested technique tries to determine the face region and identify twin individual using a conventional training images with greater precision and reliability compared to conventional method.

2. RESEARCH ABOUT FACIAL RECOGNITION

In this section, studies conducted, attempts, and optimizations made to differentiate twins based on various techniques and research gaps in them have been discussed.

R. Prema , P. Shanmuga Priya [1] propose a technique that uses Support Vector Machine and SURF to differentiate the twins. They say that facial recognition technology is a difficult field of pattern recognition, and computer vision. Speeded Up Robust Feature(SURF) is used to extract different facial features such as eyes, nose, etc. Support Vector Machine is used for classifying the faces based on the features extracted by SURF. But authors do need to improve the method of facial recognition, owing to low results and under realistic circumstances. This facial recognition technology is used primarily for security purposes, to identify the authorized person. It has daunting features such as identical faces, twins, the same person of different ages etc. in this facial recognition system. This paper reflects on methods and algorithms to separate the same faces and twins.

Shridhar S Shanbhag, Sourabh B, K. Manikantan [2] say Recognition of face through posture is a basic problem of computer vision. Authors plan to tackle this issue using three innovative methods, namely Spatial Differentiation (SD), Wavelet Transform-based Feature Extraction (WTFE), and Twin Pose Testing Scheme (TPTS), to improve the efficiency of a FR device. SD is used to enhance functionality of the facials. WTFE uses SWT 's change invariance property which neutralizes pose variations alongside TPTS. A Binary Particle Swarm Optimization (BPSO) based feature selection algorithm is used to look for the best feature subset on the feature space**.** Specific stages of the FR method are analysed, and every step is attempted to develop. Experimental results obtained by applying the proposed algorithm to four benchmark face repositories, namely Color FERET, FEI, LFW, and IFD, indicate that other FR systems are outperforming the proposed method.

P. Jonathon Phillips, Patrick J. Flynn, Kevin W. Bowyer, Richard W. Vorder Bruegge, Patrick J. Grother, George W. Quinn, Matthew Pruitt [3] They tested the ability to differentiate between identical twin twins through facial recognition algorithms. The study dataset consists of photographs taken from 126 pairs of identical twins (252 persons) obtained on the same day and 24 pairs of identical twins (48 persons) with one year apart pictures. Recognition studies are performed using three of the top submissions to the 2010 Still Face Track Multiple Biometric Evaluation (MBE) [1]. The results of the success are recorded for matching both the same day and cross year. The effects of success are broken down by lighting conditions (studio and exterior); speech (neutral and smiling); gender and age. A bootstrap method gave rise to confidence intervals. This is the most detailed study of face recognition success on twins to date in terms of both the amount of paris of twins and the lapsed period between acquisitions.

Swati Y. Dhote, A. D. Gotmare , M. S. Nimbarte [4] tell that in a variety of business activities, effective and precise authentication of individuals is highly necessary as is access to privileged information. Identical twins have the nearest genetic-based relationship, and thus the highest facial resemblance is predicted for identical twins. This paper describes facial features that are relevant for recognizing expert testimony in legal proceedings in order to establish an individual's identity from facial photographs. Experiments by authors demonstrate that modal facial recognition systems can differentiate two separate individuals who are identical twins. Authors demonstrate the influence of using a number of images of the facial surface and propose a way of distinguishing identical twins. The effects of the performance are broken down by illumination, voice, gender and age.

Waldemar Wójcik, Konrad Gromaszek and Muhtar Junisbekov [5] discussed face recognition processing, including major components such as face detection, tracking, alignment and extraction of features, and highlighted the technical challenges of the face recognition system construction. Authors concentrate on the value of the approaches that have been most effective so far. The final section of the chapter explains the approaches and techniques chosen for face recognition and their possible use in non-face recognition areas.

Daniel Saez Trigueros, Li Meng, Margaret Hartnett [6] propose that deep neural networks equipped with very large datasets have replaced conventional approaches focused on hand-crafted interfaces and conventional machine learning techniques. In this paper authors include a detailed and up-to - date literature analysis of common face recognition approaches for both conventional (geometry-based, holistic, feature-based, and hybrid approaches) and deep learning methods.

3. PROPOSED METHODOLOGY

The Project is divided into two parts. The First part is for the Real-Time facial recognition system. Whereas the second part is for Twins Recognition. The basic flow of the project goes like this:

Step by Step:

1. The image is captured from the Database / Live camera. Thereafter, image processing is carried out.
2. Preprocessing procedures for the image are done.
3. Face detection is done using an appropriate algorithm. Now the face is compared to the image that was saved in the Database when training was being performed.
4. If the face fits, we'll proceed to another verification step. This is done to ensure that if twins are tested it does not result in unauthorized access to the banking system app we created. Two-step verification ensures a high level of security to the application. It becomes very difficult for the intruder or the hacker to get the information out of our banking system app.
5. In case the face doesn't match it shows an unauthentic person and therefore access to the app is denied to that person.
6. Finally, once the face has a fit-the app it shows all faces functionality. Getting a proper understanding of the result is shown step by step process.
7. The OTP is sent to the user Email ID
8. Access to the banking menu is provided after entering the appropriate OTP else access is refused.

The system suggested implements an effective face identification and recognition using Viola Jones algorithm, PCA and ANN technique that is independent of variations in features such as colour, hairstyle, different facial expressions etc. As shown in Figure 1, the flow chart of the proposed approach is

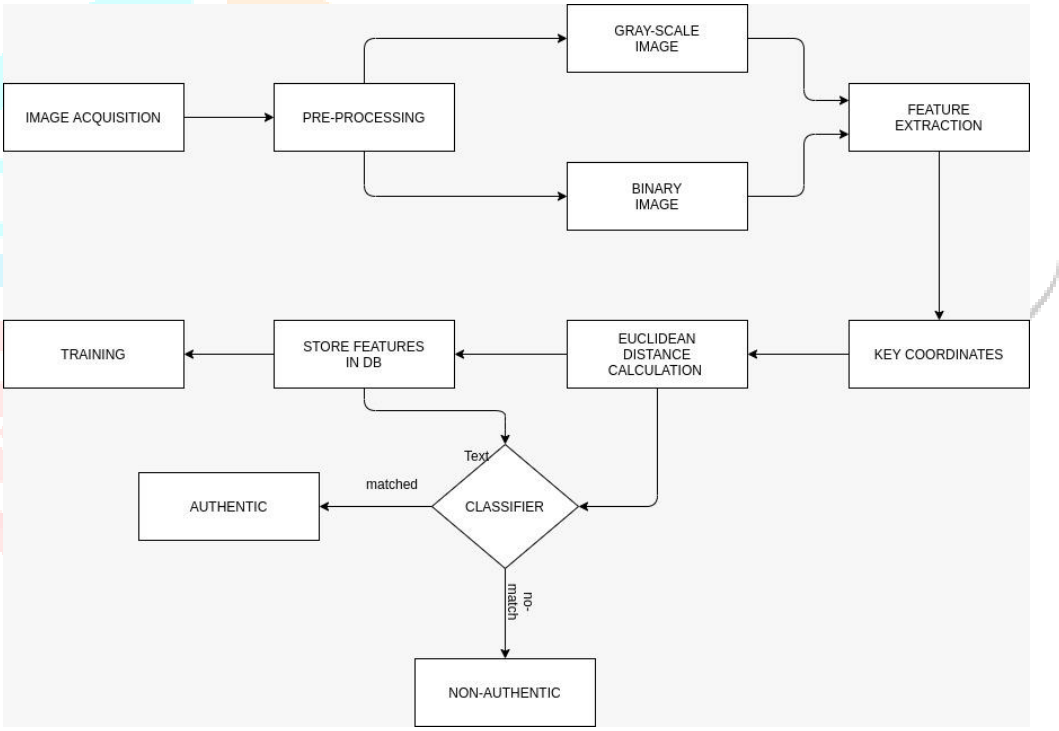

Figure 1- Proposed Methodology

3.1 Pre-Processing

A typical image database is called and is readily accessible in either colour or grey scale. Contrast stretching is done in the Pre-processing stage on the obtained image where the white pixels are coloured whiter and black pixels are coloured blacker.

3.2 Face Detection

Post contrast stretching viola-Jones algorithm is used in the image to detect faces. Due to its high detection efficiency, and its ability to run in real time, the Viola-Jones detector was chosen as a detection algorithm. Detector is most effective on facial front photographs and can cope with face rotation of 45 °, both along the vertical and horizontal axes. The three key concepts that allow it to operate in real time are the integral picture, Ada Boost and the arrangement of the cascades. The Integral Image is an algorithm used to generate cost-effectively the sum of pixel intensities in a specified rectangle in an image. It's being used to compute Haar-like features easily. It is incredibly effective to measure the amount of a rectangular region within the actual picture, involving just four additions for every arbitrary rectangle dimension. AdaBoost is used as a linear combination of weak classifiers for the creation of strong classifiers. The hair functions used in the voila-Jones algorithm are as seen in Fig 2

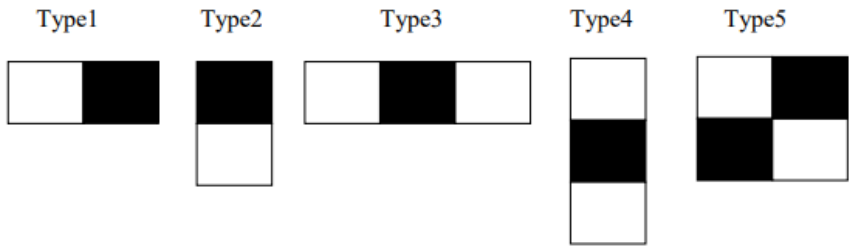

Figure 2- Haar-like features in Viola Jones

The haar characteristics above may be of varying height and width. The number of black pixels and the number of white pixels are determined from the hair function added to the forehead, and are subtracted to produce a single value. If this attribute is more of a part of the face in that area, it is known as lips, nose, jaw, etc. The hair characteristics are measured in the image and would be approximately 160000 + features per image. In real-time implementations, summing up the entire image pixel and then subtracting them to get a single value is not efficient. This may be reduced by using the classifier Ada boost. Ada upgrade is reducing redundant functionality. Instead of summarizing all the pixels now this integral representation is used as seen in Figure 3.

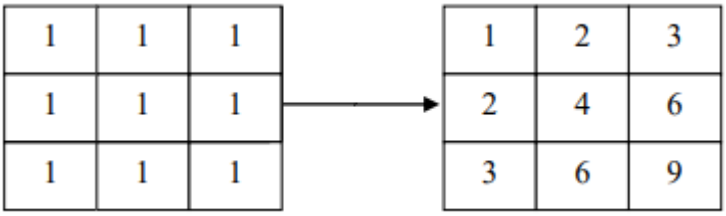

Figure 3- Integral Image

The top pixels and left pixels are removed to get a new pixel value and all the points around the patch are inserted to get the sum of all pixel value. Ada raise defines pertinent features and unrelated features. After defining important features and irrelevant features both of them will be given a weight by the Adaboost. It builds a strong classifier as a linear Weak classifier combination.

Weak classifier = { 1; Identified a feature (ex: nose)
0; Not Identified any feature (ex: no nose in image)

Almost 2500 features are calculated. Further, cascading will reduce the amount of computations. Here a combination of images is held in a separate set of classifier, and so on in a cascading. Using this approach one can determine in a faster time whether that's a face or otherwise, and can refuse it if one classification algorithm fails to produce a necessary output to the next level. The detected face is cropped to a standard resolution of 100x100, and resized. The next move is to use principal component analysis and artificial neural network algorithm to classify the detected signal.

3.3 Feature Extraction

Features like nose eyes and mouth are extracted from the detected face and Key coordinates of features are noted down. And then Euclidean distances are calculated. It is the most common use of distance. When people talk about distance, this is what they are referring to. Euclidean distance, or simply 'distance', examines the root of square differences between the coordinates of a pair of objects. This is most generally known as the Pythagorean Theorem. For testing, we used the Euclidean distance classifier, for calculating the minimum distance between the test image and image to be recognized from the database. If the distance is small, we say the images are similar and we can decide which the most similar image in the database is.

PCA is used for extracting traits from a human face image. Principal Component Analysis (PCA) is used to remove the features from a facial region cropped and dimensioned. It is used as an instrument in predictive analysis and is used to is used to turn higher dimensional data into lower dimension data**.** Through using the principal component analysis technique, a bunch of facial images in a training range of size M x M are transformed into lower dimensional facial images. Another of the statistical techniques used to transform a set of clustered N variables into a collection of uncorrelated k variables called main components is the principal component analysis of the components.

Using PCA, once the functions are extracted and chosen, the next step is to calculate the distance between images. Most facial recognition technologies from the last decade aid in assessing the distance estimation appropriately. The difference between two images is a major problem in computer vision and image recognition. The last step in facial recognition is to

determine the difference between two pictures. Image similitude is the difference between two image vectors. The difference between representations of feature spaces is used as the basis for recognition decision.

The Euclidean distance is used to calculate the distance between images. Euclidean Distance is defined as the straight line distance between two points which examines the root of square differences between a pair of objects' co-ordinates. Euclidean distance is calculable using the following equation:

$$EuclideanDistance(X,Y) = \sqrt{\sum_{n=1}^{No.of\ Images} (X_n - Y_n)^2}$$

3.4 Face Classification

The data taken from the photographs was interpreted in this point using a previously qualified ANN. To understand the Artificial Neural Networks concept one should know how the natural neural network system works in the brain. Natural Neural Networks network includes neurons as the essential building blocks of the brain. Both neurons are linked along a path toward carrying electrical impulses which are considered synapses. Along these pathways they connect and about 100 billion neurons are in a brain.

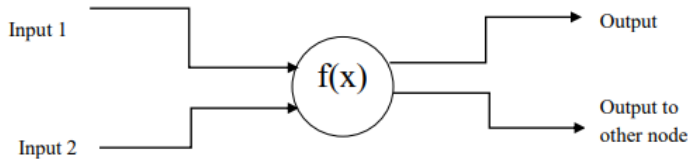

Figure 4- Individual Neuron Cell

Finally features are extracted and stored in the database. These features are used while training the model. Once all the features are stored in the database. Training of the model begins. In MATLAB Neural Network Training is performed by NN-train tool. All the above training steps are followed in testing as well. Extra steps followed in testing are: Features extracted from the test image and the features of the training images are fed into the classifier. The classifier generates two parameters. One for the grayscale and one bit for the map. Matlab toolbox NN-classify is used for classification purposes. For the case of recognizing twins, stricter guidelines are set. Since the similarity of twins are extremely high. Accordingly we set the parameter known as the threshold value for comparison. For e.g.-Threshold value set to 90 will say person is a twin if the matchingness is greater than 90.In this way the given algorithm works for both normal Facial Recognition as well as Twins Recognition.

4. RESULT AND ANALYSIS

Applying the Voila-Jones algorithm to the image in Figure 8 is obtained Known facial picture seen in Figure 5(bounding box on marked object. This is then resized to 100x100 pixels and is to measure the hair characteristics and delete all the associated information.

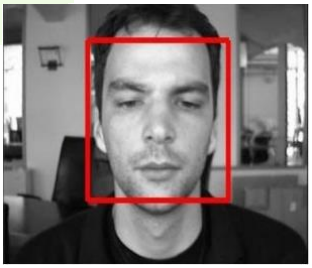

Figure 5- Face Identified by Voila Jones Algorithm(Red Boundary)

Voila-Jones algorithm recognizes the key features of the face, identified by a Bounding box is seen in Figure 6 and is used to evaluate the nodes corresponding to the portion of the face found.

Figure 6. Various Facial Parts Detected

The characteristics extracted by the Voila-Jones algorithm are represented as nodes and these nodes are joined together to form a shape ensuring that all nodes are connected and naming the connected lines with reference numbers as shown in Figure 7.

Figure 7- Face Feature Calculation

Proposed face detection and recognition using Viola-Jones Algorithm and Neural Networks with 92.10 percent accuracy. To analyze the accuracy of the system, we use confusion matrix. Thus, the proposed method of defining a individual in an picture is more reliable compared to the other methods.

TRUE POSITIVE	FALSE NEGATIVE
36	02
FLASE POSITIVE	**TRUE NEGATIVE**
04	38

Figure 8- Confusion Matrix

True Positive: Recognising the user of the account.

False Positive: Not being able to recognise the user of the account.

False Negative: Authenticating wrong person as the owner of account.

True Negative: Differentiating the twin as the owner and not the authentic person.

N=76

ACCURACY = (TP+TN) / (FP+FN+TP+TN)
= (36+34) / (36+34+04+02)
= 70/76
= 0.921
= 92.1%

PRECISION = TP / (TP+FP)
= 36 / (36+04)
= 90%

RECALL = TP / (TP+FN)
= 36 / (36+02)
= 94%

Twin Facial Recognition system gives accuracy of 92.1%, which indicates that system is to an extent of 92.1 % giving accurate result. This system gives precision about 90 % tells us how often an authentic person is given access to the system, this system gives about 94 % of recall. The results obtained consisted of all the results expected at the beginning of the project. The Twin Facial Recognition System worked with no errors.

5. CONCLUSION

The paper uses Viola-Jones, synthesis of PCA and ANN strategies to offer an efficient method for twin face identification and recognition. The efficiency of the proposed method is contrasted with other current methods of face recognition, and it is found that the proposed method achieves greater accuracy in identification. In a wide variety of applications facial identification and recognition plays a crucial role. A high degree of accuracy in identifying a individual is needed in most applications, thus the proposed approach can be considered when opposed to the current methods.

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