A Twin Prediction Method Using Facial Recognition Feature

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DECLARATION

We, hereby declare that this thesis is based on the results found by ourselves. Materials of work found by other researcher are mentioned by reference. This Thesis, neither in whole or in part, has been previously submitted for any degree.

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ABSTRACT

The high similarity between identical twin is known to be a great challenge for Face Recognition Technology. As Face Recognition Technology handles identification and the verification of identity claim of a person, it is really important to have a method which can overcome identical twin problem. In this research, we try to demonstrate a model which can predict and compare identical twin. In this method, we used histogram, RGB colors to find the best criteria for matching for initial stage. Later, we used GLCM technology which measure the texture analysis of the images where some parameters are being used for calculation. After the analysis, we delivered a conclusion based on our results we found.

CHAPTER I

INTRODUCTION

1.1 Motivations

For years, we have been seeing that so many people have been caught while giving a proxy exam or proxy interview for someone else whose face is very similar to that person or he/she is identical twin. Even there are incidents where these guys couldn't be caught at the very initial stage and so many years passed then they have been caught. This could be a serious security concern when government is recruiting in any armed forces and governmental post. All these points made us to work on this problem and to build a model which can be a solution of this.

We also try to build a simple model to run a simple facial recognition tool to quickly identify twins rather than long & complex process of highly used facial recognition technology which is very costly and time consuming. In this research, we try to deliver that model which can overcome these types of problem.

1.2 Information about Facial Recognition Technology

Every face has numerous, distinguishable landmarks, the different peaks and valleys that make up facial features. These landmarks are defined as nodal points. Each human face has approximately 80 nodal points. Some are-

- Distance between the eyes
- Width of the nose
- Depth of the eye sockets
- The shape of the cheekbones
- The length of the jaw line

These nodal points are measured creating a numerical code, called a faceprint, representing the Face in the database. At present time 3D, facial recognition uses distinctive features of the face, where rigid tissue and bone is most apparent, such as the curves of the eye socket, nose and chin to identify the subject.

These areas are all unique and don't change over time.

1.3 Overall Idea

In this thesis, we mainly focused on our work that how we are going to approach the problem to find an efficient solution. We did some research related with our problem. Then we discussed about the feature of our system. Besides our model is also highlighted here along with details analysis of result. Some possible future work of our system is also mentioned later.

1.4 Thesis Orientation

The rest of the thesis is organized as follows

- Chapter II includes background information along with features of our system and objective of the model.
- Chapter III presents the proposed model of our prediction approach using of histogram & GLCM features to overcome the problem.
- Chapter IV demonstrates the experimental results and comparison.
- Chapter V concludes the thesis and states the future research directions.

CHAPTER II

BACKGROUND INFORMATION

2.1 Introduction

We have gone through papers related to our topic and thus we get some information about how FRT works and how it can be used in our program. In [1], authors briefly discussed about how face -recognition in humans is improving day by day using Eigenfaces and 3D facial data representations. Another paper talked about how twin's facial similarity has impact on conventional face recognition systems [2]. In [3], authors showed a survey paper of policy and implementation issues of facial recognition system. Which also described various facial recognition algorithms. According to [4], researcher showed many different facial features which can be used to analyses identical twins faces.

As we all know, making a facial recognition method is not an easy task. Results are not so accurate sometimes because of so many parameters are being considered. Color of the picture, facial expression, partial face make serious problem for prediction. We have to consider these limitation for this method also.

2.2 Features

- Automatically detect face, eyes & lips from random picture.
- Crop the detected part.
- Can compare between two faces for similarities.
- It can show the similarities between eyes and lips.
- Can show the details percentages of analysis.
- Based on results prediction can be made.

2.3 Objectives

- Predict Twins.
- Can be used to prevent security breach because of proxy incident.
- Match the database information which can be done in future implementation.
- Best possible way to reduce errors.
- Details parts of the faces can be used for other purposes also.

Chapter III

Proposed Model

3.1 Introduction

Figure 1.0 demonstrates the work flow of our proposed model. It demonstrates how our proposed Model is going to work step by step. First, it's going to take human pictures input which are needed to be checked whether they are twin or not. After that we are going to identify the face, lips and eyes from given pictures using Haar-Cascade Classifier. Then our proposed model used RGB HISTOGRAM on those different parts to take the initial decision whether this might be a potential twin candidate or not. For this we set a percentage of 60 for initial decision. If it turns out that given input is potential twin candidate then the model will follow a complex computation to take the final decision about the twin detection. User will have the option whether he will go for further calculation for better results or not in next step. We set about 90 percent for details facial analysis. In this complex computation, our model used Gray-Level Co-Occurrence Matrix Based on Contrast, Energy, Homogeneity, Dissimilarity, ASM, Correlation to take the ultimate decision.

Figure 1.0: Proposed Model

3.2 Working with haar cascade classifiers

Object Detection using Haar feature-based cascade classifiers is efficient and effective object detection method. This classifier is related to a field of informatics which computers to see and way computer gather and interpret visual information. Generally, the image is first processed on a lower level to enhance picture quality, for example remove noise. Then the picture is processed on a higher level, for example detecting specific patterns and shapes, and thereby trying to figure out, what is in the picture [5]. As we are working on detection of human faces. We saw that the areas around the eyes are darker than the areas on the cheeks. Haar-like feature helped us for detecting face as it's a set of two neighboring rectangular areas above the eye and cheek regions. [6] To work with face detection. Initially, the algorithm needs a lot of positive images (images of faces) and negative images (images without faces) to train the classifier. When the classifier is trained, it can be applied to a region of interest (of the same size as used during the training) in an input image. The classifier outputs a "1" if the region is likely to show the object (i.e., face), and "0" otherwise. To search for the object in the whole image one can move the search window across the image and check every location using the classifier. The classifier is by default designed so that it can be easily "resized" in order to be able to find the objects of interest at different sizes, which is more efficient than resizing the image itself. So, to find an object of an unknown size in the image the scan procedure should be done several times at different scales. The cascade classifier consists of a list of stages, where each stage consists of a list of weak learners.

The classifier will yield final verdict of positive, when all the stages, including the last one, yield a result, saying that the object is found in the image. This ensures the accurate result of identifying the object [7].

3.3 Working with histogram

At the very next step of our model we used Color Histogram to take the initial decision that whether it is a potential twin input or not. Color is one of the most outstanding features of the image. It is the most important human visual content and it is very easy to calculate. It is widely concerned by many researchers as it does not effect by natural rotation, scaling and translation of an image [8]. Histogram represents the distribution of pixel intensities (whether color or grayscale) in an image of RGB. It can be visualized as a graph (or plot) that gives a high-level of the intensity (pixel value) distribution. We are going to assume an RGB color space, so these pixel values will be in the range of 0 to 255. When plotting the histogram, the X-axis serves as our “bins”. If we construct histogram with 256 bins, then we are effectively counting the number of times, each pixel value occurs. In contrast, if we use only 2 (equally spaced) bins, then we are counting the number of times a pixel is in the range [0, 128) or [128, 255]. The number of pixels binned to the x-axis value is then plotted on the y-axis. By simply examining the histogram of an image, we get a general understanding regarding the contrast, brightness and intensity distribution [9]. But histogram alone cannot analysis a picture in a deep level of features [10], which would cause inaccurate decisions sometimes. If two different images have the same color distributions then histogram would give the decision as twin detected, but in reality, those inputs might not be twin. To overcome this problem, we used the various features of GLCM to find more accurate result of twin detection.

3.4 GLCM

A co-occurrence matrix, also referred to as a co-occurrence distribution, is defined over an image to be the distribution of co-occurring values at a given offset Or Represents the distance and angular spatial relationship over an image sub-region of specific size. The GLCM is created from a gray-scale image. The GLCM is calculates how often a pixel with gray-level (grayscale intensity or Tone) value i occurs either horizontally, vertically, or diagonally to adjacent pixels with the value j . GLCM texture considers the relation between two pixels at a time, called the reference and the neighbor pixel. The neighbor pixel is chosen to be the one to the east (right) of each reference pixel. This can also be expressed as a (1,0) relation: 1 pixel in the x direction, 0 pixels in the y direction.

0	0	1	1
0	0	1	1
0	2	2	2
2	2	3	3

This is how the values being set for further calculation. These are the values of image gray levels.

3.4.1 Working with contrast

In Gray-Level Co-Occurrence Matrix the feature Contrast returns a measure of the intensity contrast between a pixel and its neighbor over the whole image. Contrast is 0 for a constant image. The property Contrast is also known as variance and inertia. This is also called sum of squares variance. If we look at its formula then we would the meaning of Sum of squares variance.

$$\text{Contrast} = \sum_{i,j=0}^{N-1} P_{ij}(i - j)^2$$

When i and j are equal, the cell is on the diagonal and $(i-j) = 0$. These values represent pixels entirely similar to their neighbor, so they are given a weight of 0. If i and j differ by 1, there is a small contrast, and the weight is 1. If i and j differ by 2, contrast is increasing and the weight is 4. The weights continue to increase exponentially as $(i-j)$ increases.

Figure 1.1: GLCM Contrast

3.4.2 Working with energy

In Gray-Level Co-Occurrence Matrix the feature Energy returns the sum of squared elements in the matrix. Energy is 1 for a constant image. The property Energy is also known as uniformity, uniformity of energy, and angular second moment(ASM).

$$\text{Energy} = \sum_{i,j=0}^{N-1} P_{ij}^2$$

3.4.3 Working with homogeneity

In Gray-Level Co-Occurrence Matrix the feature Energy returns a value that measures the closeness of the distribution of elements in the GLCM to the GLCM diagonal. Homogeneity is 1 for a diagonal GLCM. Dissimilarity and Contrast result in larger numbers for more contrast windows. If weights decrease away from the diagonal, the result will be larger for windows with little contrast. Homogeneity weights values by the inverse of the Contrast weight, with weights decreasing exponentially away from the diagonal.

$$\text{Homogeneity} = \sum_{i,j=0}^{N-1} \frac{P_{ij}}{1+(i-j)^2}$$

Figure 1.2: GLCM Homogeneity

3.4.4 Working with correlation

In Gray-Level Co-Occurrence Matrix the feature Correlational measure of how correlated a pixel is to its neighbor over the whole image. Correlation is 1 or -1 for a perfectly positively or negatively correlated image. Correlation is Nan for a constant image. The Correlation texture measures the linear dependency of grey levels on those of neighboring pixels.

$$\text{Correlation} = \sum_{i,j=0}^{N-1} P_{ij} \frac{(i-\mu)(j-\mu)}{\sigma^2}$$

It measures the joint probability occurrence of the specified pixel pairs.

3.4.5 Working with ASM

Angular Second Moment is also known as Uniformity or Energy. It is the sum of squares of entries in the GLCM Angular Second Moment measures the image homogeneity. Angular

Second Moment is high when image has very good homogeneity or when pixels are very similar,

$$ASM = \sum_{i,j=0}^{N-1} P_{ij}^2$$

Where i, j are the spatial coordinates of the function p (i, j).

In [11], author discussed about how fast GLCM can be computed when using linked list rather than traditional implementation and also showed Computational Speed Comparisons between different features like Contrast, Energy, Homogeneity, Correlation, ASM.

Table 1.0 – Symbol Table

Symbol	Definition
i	Value i occurs either horizontally, vertically, or diagonally
j	Value of adjacent pixel of i
P_{ij}	Element i,j of the normalized symmetrical GLCM
N	Number of gray levels in the image as specified by Number of levels in under Quantization on the GLCM texture page of the Variable Properties dialog box.
μ	The GLCM mean (being an estimate of the intensity of all pixels in the relationships that contributed to the GLCM)
σ^2	The variance of the intensities of all reference pixels in the relationships that contributed to the GLCM

Chapter IV

Analysis and Result

4.1 Introduction

In our proposed model, we discussed the procedure of our approach to identify the twins. For this, we have divided the approach with some steps. First is the identification of the face from random image. Second is the extraction steps where we extract or cropped the faces & then extract the lips and eyes. Third step is the calculating the RGB value for the eyes and lips. Fourth step is the calculating the average of eyes and lips then and compare with the other faces by error calculation methods. If the results are less than 60 percent, we take an initial guess that these pairs are not twins. If the results are above 60 percent, then we go to next steps. Fifth step is the calculating the GLCM parameters of the cropped faces that we extracted earlier in our program. We calculated 6 parameters of GLCM which are contrast, energy, homogeneity, dissimilarity, asm & correlation. After calculated the values of parameters, we averaged them. Last step is the final decision where we error calculate the averaged value with the next pair. If the results are less than 80 percent, we can say that these pairs are not twins otherwise above 80 percent, we can say these pair might be twins. For these analysis, we used Python 2.7 programming language with OpenCv, Numpy, Matplotlib, Skimage etc library.

4.2 Classifiers

Our model used three classifiers to determine the faces, eyes & lips. The face detecting is **haarcascade_frontalface_default.xml**, eyes detecting is **haarcascade_eye.xml** & lips detecting is **haarcascade_mcs_mouth.xml**. We applied these classifiers at the very first of our model.

Let's analyse how these classifiers determine our images.

4.3 Detection

We take these two twins at first & name it first one is **Twin1a** & second one is **Twin1b**

Figure 1.3: **Twin1a**

Figure 1.4: **Twin1b**

Now, we applied our classifiers, first the faces these figures are marked then cropped. Then, the cropped faces are marked by the eyes and lips which are cropped separately and saved for calculation.

Figure 1.5: **Twin1a (Marked)**

Figure 1.6: **Twin1b (Marked)**

After we extracted eyes & lips from the cropped faces, we calculated the RGB values the left eyes of these twins. For this, we calculated the amount of the pixels for the RGB colours.

Calculating colours for eyes & lips will give us the initial guess whether these pairs are twins

Or not. Here is the histogram of these pairs for left eyes.

Figure 1.7: **Twin1a (Histogram)**

Figure 1.8: **Twin1b (Histogram)**

From the histogram of left eyes for two twins, we can clearly see that the RGB colour pixels position in bins are almost same. So, we can clearly get an idea that the eyes of these pairs are almost same. We can be surer by calculating the values of RGB of the eyes. The calculation is below

Table 1.1(Left Eyes RGB)

RGB	Twin1a	Twin1b
R	1170	1834
G	8183	5912
B	800	1435
Total	10153	9181

After that we use error calculating method to find out the percentage for matching of the these eyes.

For eyes: $100 - \text{Abs} [(Twin1a - Twin1b) / \text{Max} (Twin1a, Twin1b) * 100]$

So, the results we found for eyes is 85.78%

Similarly, the results for lips is 77.89%

The average is **81.83%** which is more than **60 percent**. So that, we can say that these pairs might be twins.

Let's go to the GLCM part.

Table 1.2 (GLCM 1)

GLCM Parameters	Twin1a	Twin1b
Contrast	31.8	26.7
Energy	53.6	53.3
Homogeneity	90.01	89.6
Dissimilarity	86.70	88.2
ASM	21.8	21.7
Correlation	28.7	28.5

From the table, we can see all the GLCM parameters and their corresponding value we found for the cropped face which we did earlier in our program.

After getting all the parameters, we calculated the percentages for all of this like eyes & lips

Percentage for faces contrast: 83.99

Percentage for faces energy: 99.55

Percentage for faces homogeneity: 99.55

Percentage for faces dissimilarity: 99.60

Percentage for faces ASM: 99.11

Percentage for faces correlation: 98.23

Average percentage is: 96.67

Which is more than **80 percent**, so we can say that these pairs are predicted as **Twins**.

Let's check another pairs and see these are twins are not.

We will take these twins now and compared with the first one. Second one name is **Twin2a**.

Figure 2.1: **Twin1a**

Figure 2.2: **Twin2a**

Just like previous, Model will detect faces, eyes & lips

Figure 2.3: **Twin1a (Marked)**

Figure 2.4: **Twin2a (Marked)**

Now, drawing the histogram of left eyes for these pairs.

Figure 2.5: **Twin1a (Histogram)**

Figure 2.6: **Twin2a (Histogram)**

From the histogram, we can say that the eyes are a little bit different than the previous one. Here is the calculation of the RGB value.

Now, the RGB calculation of the eyes

Table 2.1 (Left Eyes RGB 2)

RGB	Twin1a	Twin2a
R	1170	2966
G	8183	6850
B	800	1711
Total	10153	11527

We follow the error calculation just like previous & the results for eyes & lips are

Percentage for Eyes: 92.63

Percentage for Lips: 42.59

Average is: 67.61 which is more than **60 percentage** but less than **70 percentage**. So, the chances for these pairs are twins is not so high.

Now, calculating the GLCM part

Table 2.1 (GLCM 2)

GLCM Parameters	Twin1a	Twin2a
Contrast	31.8	18.15
Energy	53.6	54.8
Homogeneity	90.01	93.4
Dissimilarity	86.70	95.0
ASM	21.8	13.8
Correlation	28.7	30.0

Percentage for faces contrast: 57.00

Percentage for faces energy: 97.86

Percentage for faces homogeneity: 96.30

Percentage for faces dissimilarity: 63.51

Percentage for faces ASM: 95.76

Percentage for faces correlation: 91.20

Average percentage is: 83.60 which is less than **90 percent**, so we can say that these pairs are predicted as **not twins**.

We have used our simulation with adult twins also.

Figure 2.7: **Twin3a**

Figure 2.8: **Twin3b**

Here is the complete result we got for these pairs.

Percentage for Eyes: 86.01

Percentage for Lips: 77.79

Percentage for faces contrast: 70.87

Percentage for faces energy: 96.24

Percentage for faces homogeneity: 98.87

Percentage for faces dissimilarity: 85.59

Percentage for faces ASM: 92.63

Percentage for faces correlation: 96.49

From the above result we can see that, the average of eyes and lips are pretty high **81.9 percent** and the average percentage of GLCM part of the face is **90.15 percent** which is more than 90 percent.

So, we can say that these adult pairs are **twin** also.

4.4 Comparison

After measuring and calculating all the values, we can deliver a comparison between these pairs.

Table 2.2 (Comparison)

Twins	Eyes	Lips	Faces	Twins
Twin1a vs Twin1b	85.78	77.89	96.67	Yes
Twin1a vs Twin2a	92.63	42.59	83.60	No
Twin3a vs Twin3b	86.01	77.79	90.15	Yes

As we can see after checking 3 pairs, we found two of them are twins which actually they and one of them is not twin. The not twin pair has less percentage than the actual twin pair.

We also run this model in various actual twins or not twins pairs. The results we found almost matches with the percentages we found here.

CHAPTER V

FUTURE WORK

5.1 Future work

Our next target will be implement it as a whole system where it can automatically search through in a database to find out potential twin face which can cause any security vulnerability.

For improving accuracy, we will try to add new feature in our program so that more complex pictures can also be detected though our program.

5.1 Concluding Remarks

In conclusion, we think we will be able to prevent security vulnerabilities which is related to Twin face detection and identification. Comparison between two faces and ratio analyzer will make this program more accurate and efficient in real world problem solving. We hope this model will bring a lot of positive change in the future of security system.

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