Hairstyle Recommendation System Based on Face Recognition

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ABSTRACT

In this paper, we are using k-nearest neighbour in classifying human face images into one of the five basic face shapes (Oblong, heart, square, round and oval) to recommend hairstyle suitable for that face shape. We tried to achieve the same using support vector machines (SVM) and multi-layer perceptron (MLP). Though MLP performed better than SVM, the results obtained from KNN were better than both SVM and MLP classifiers. For this paper, the data used contains selected 300 images from Labeled Faces in the Wild (LFW) dataset and few images from the celeb-A dataset. Each image used is manually labelled with an attribute called desirability that scales from 1 to 5. 5 indicates the hairstyle best suited for the face shape and 1 indicates that the hairstyle is not suitable for this face shape. Total of 25 features are used to train the classifiers out of which 24 are procured from the input image and the 25^{th} feature is the gender of the person whose image is used. After the face shape is determined, a table lookup would suggest which hairstyle would be suitable and which hairstyle would not be suitable. Thus, using this approach we were able to recommend hairstyles with face shape accuracy being 62.3% .

1 INTRODUCTION

Hairstyle of a person is very important. It holds the capability to enhance or degrade a person's appearance. A good hairstyle makes a person feel more confidant. On the contrary, a wrong hairstyle might make someones look unattractive and make her or him lose their confidence and grace. For this reason, a lot of people like spending lot of money on getting a good hairstyle. Many people choose to select their new haircut from magazines without understanding which one would perhaps suit their face. Many of the hairstylists and experts believe that the hairstyle most suitable to a person depends of the shape of person's face. A tutorial to find out ones face shapes was introduced by one of the beauty expert [8]. This paper focuses on a recommendation methodology which would recommend hairstyles to a person based on her face shape. With the advances of re-trainable custom image classifiers, it has become a lot simpler to design customized image classifiers like face shape classifiers. So, given a frontal view image of a human face, the classifier would be able to determine the face shape.

Knowledge of one's face shape is more commonly used by hairstylists for recommending hairstyles to their clients. Most hairstylists advice their clients to have a haircut that complements their face shape. For example, a man with round face would be advised to go for a haircut that would have more volume of hair on the center of their head when compared to sides while a woman would be advised a hairstyle that would add length like layered bangs.

For this paper, the images are labeled manually with the desirability attribute. However, this value can be extracted from social networking websites which would give a better perspective about which hairstyle is suitable and is liked by what percentage of the audience. Also, the table lookup phase can be replaced by a deep learning algorithm that can predict the future trends in hairstyles and recommend hairstyles on that basis. Recommendation can be made more accurate by taking into consideration the hair texture, hair thickness and hair color of the subject. The same approach may be used to recommend styles for beard or which sunglasses may be suitable to person based on their face shape.

The second section of this paper covers what research is currently being carried out for this problem and the third section includes the methodology which is followed by the experimental results. This is followed by future works and conclusions drawn out.

2 RELATED WORK

Quite often face shape classifiers that are quite easily accessible in various context which may come as online tutorial, web applications, and applications that may be installed in mobile devices. There also exists few scientific articles which are peer reviewed.

In the paper [4] , the approach proposed has achieved a very high accuracy in determining face shape by retraining the last stage of inception v3 classifier which uses a convolutional neural network (CNN). Convolutional neural networks have gained popularity in solving problems related to image classifications. Originally CNN were designed to classify 1000 classes using millions of images. But in this case, it has been retrained to solve the problem of image classification in a customized manner. However, the approach described is gender biased and has used only images of women to train the classifiers.

Yet another approach in [3] provides a methodology to classify human faces using the active appearance model and face segmentation technique. The face segmentation technique is used to determine the tip of the forehead. It includes the use of the active appearance model and the landmarks are obtained using the faceTracker software[5]. This paper takes majority of the inspiration from [4] for classifying human faces. However, this approach is not very effective in finding features in the lower portion of the face especially when we have a user with a thick beard.

Few online guides have designed a rule-based approach that requires the user to answer questions related to their face shape. For example, it would contain a question regarding whether the face the jaws are rounded or wide[3] [7]. Most basic approach requires the user to outline their face shape on a mirror and compare the outline to predefined classes. However, this approach is very subjective.

An online application eliminates the requirement to use a mirror by allowing the user to superimpose one of available face shape outlines on an uploaded input image [5]. The drawback of this feature is that the face shape classification becomes subjective. What might appear as round to one person might appear oval to another person. Due to this reason, the accuracy of face shape classification would be very low.

3 METHODOLOGY

In this section we describe the methodology used behind classifying human faces in to face shapes and recommending hairstyles.

A Rules for face shape determination

Figure 1 : Examples of images with face shapes often cited as (left to right) heart, oblong, oval, round and square

For this paper we consider five broad categories to classify face shapes as illustrated in [3] and [4]. The five categories are as follows :

a. Oval shaped : A oval shaped face is characterized by the fact that the ratio of height to width of the face is approximately equal to 1.5.

b. Heart shaped : A heart shaped face has a characteristic where the width of the face is greater than the width of the forehead and it is characterized by a pointed chin. So the width of jawline would be very small compared to width of the face by measuring the distance between the cheekbones.

c. Round shaped : A round shaped face is characterized by the fact that the height and width of the face would be equal.

d. Square shaped : People with square shaped face usually have angular jawline and the width of the face and the width of the jawline are equal.

e. Oblong shaped : An oblong shaped face is characterized by the fact that the height of the face is very long when compared to the width of the face.

Generally, it is difficult to determine the face shape as most of the rules proposed previously can not be expressed mathematically. So the above mentioned rules provide a good basis for qualitative face shape determination.

B Dataset

The data set for this project includes 300 selected images from [1] and [2] . Each image in dataset is provided an attribute named desirability that scales from 1 to 5. If the desirability is 5 then the hairstyle of the person in the image is very popular for this face shape and if the desirability is 1 then the hairstyle is not liked for this face shape. The setting of this attribute has been done manually and can be subjective.

Each of the image in the dataset is further classified into five shapes mentioned in 3A. This is done to train the classifiers to obtain the face shape of the input image. The classification in this step is also done manually by looking into few websites on the Internet for the information regarding face shapes as it was done in [1] and [2]. Most of the images used for recommending hairstyle were that of celebrities or style icons. This is because, quite often people try to copy the hairstyles of celebrities to look attractive and it becomes easier for hairstylists to identify what type of hairstyle their clients prefer

C Feature Extraction

Features required to train the classifiers are extracted using haar cascade classifiers and voila jones. The trained classifier for frontal face would provide 60 points in the face. The obtained points would include all the landmarks in the face including the points around the eyes, nose and edges of the mouth. Out of these points, the point we are interested in would only include the border of the face.

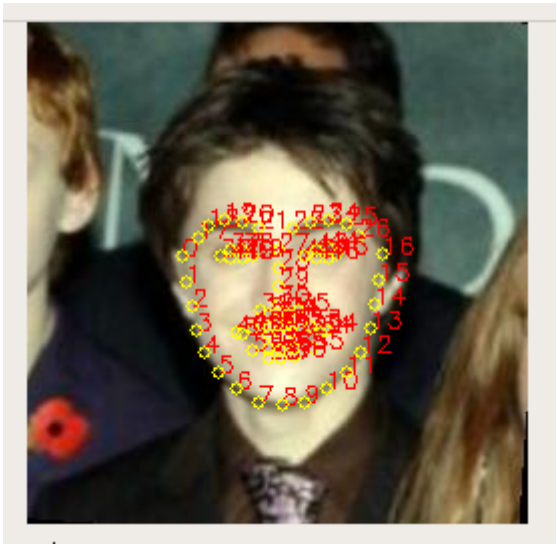

Figure 2: The landmarks obtained using haar cascades.

A drawback of using this technique is that the landmarks obtained would only include the region from the eyebrows until the chin and the hairline would be ignored as illustrated in figure 2.

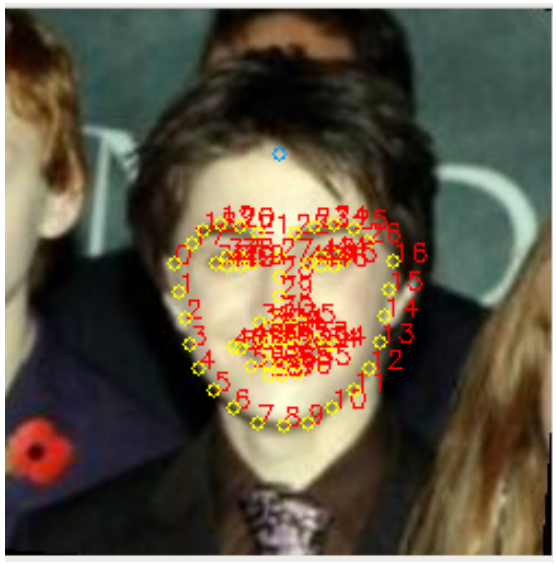

Figure 3 : Additional feature obtained using face segmentation technique (marked by blue point)

In order to deal with this drawback we use the face segmentation technique as illustrated in [3]. In this approach, we compare the skin tone on tip of the nose until the top of the image. The tip of the nose corresponds to the 27^{th} point in the obtained landmarks. The comparison is terminated once a significant colour change is observed. This would give us the the start of hairline as illustrated in figure 3.

Features to train the classifiers were extracted the same way as illustrated in [3]. 27 features were extracted per image to train the classifiers. The features include the ratio between the height of the face and the width of the face,ratio of width of the jawline to width of the face and the angles that the line from the chin to each one of 16 facial points make with respect to the vertical. Angles with respect to the normal were used to take into account the slight inclination of the faces in some of the images. Another feature that gets added to the list is the gender of the person. The features illustrated above can be mathematically expressed as follows:

a) Face height : The euclidian distance between the point obtained using page segmentation and the 18^{th} point in the landmarks obtained.

b) Face width : The euclidian distance between the 1^{st} and 17^{th} point in the landmarks obtained

c) Jawline width : The euclidian distance between the 5^{th} and the 13^{th} point in the landmarks obtained

d) Angles : In this case we consider the angle a given landmark from the left ear down to chin makes with the horizontal axis. The same is calculated for the right side of the face.

All these features are saved in a CSV file out of which 80 percent is used to train the classifiers and 20 percent is used for testing the accuracy.

D Training the classifiers

The data which was split in the previous stage was used for training in the following methods:

a) Multilayer Perceptron (MLP) : MLP is a class of artifcial neural network which consists of at least three layer of nodes. Artificial neural network is a parametric model of machine learning which is capable of generating both linear and non-linear classifier.

b) Naive Bayes Classifier (NBC) : Naive Bayes is a simplified method for constructing classifiers. A naive Bayes classifier considers each of the features in the feature vector contribute independently to the probability to classify the face shape in our case.

c) K-Nearest neighbor classifier : k-nearest neighbor classifiers find out the class to which a particular point belongs by examining the training samples which have the smallest Euclidean distance from it. The selected model looks at the five nearest neighbors for classification.

E Recommending Hairstyles

Once we determine the face shape using a classifier, next thing we need to do is perform a table lookup on the data we have. The algorithm selects three top rated hairstyles and three hairstyles with the least desirability. The top rated hairstyles are the one that would be suitable for the classified shape and the ones with least desirability are the ones that would not be suitable for the face shape of the user. For example, if the classifier classifies the input image as heart shaped face, the algorithm would look top three and bottom three images in the heart shaped face dataset.

Note that each image in the table is labeled manually by one person. This means that the desirability associated to each image is subjective and may not according to agreement of all individuals as the liking or not liking of a particular person varies from person to person. A middle-aged man would be more inclined in selecting a hairstyle which is suitable for formal events where as a teenager would love to experiment with hairstyles and would prefer a hairstyle which would make him look different from other people of his age group.

This entire process of setting the desirability can be automated by extracting images and the response for the image of celebrities from social networking websites. For example, if we have a square shaped person, one can find various images of a celebrity (say Tom Cruise) who has a square shaped face from social networking website and see the response for each image. If the response of an image is highly positive, that particular image would have a high desirability. and 20 percent is used for testing the accuracy.

4 RESULTS

The results obtained below illustrate the accuracy using various classifiers :

A Confusion matrix for NBC

Face Label	Predicted Label					Accuracy (%)
	Heart	Oblong	Oval	Round	Square	
Heart	7	3	3	2	1	70
Oblong	2	5	0	1	0	31.25
Oval	1	4	7	3	3	58.33
Round	0	1	0	2	3	20
Square	0	3	2	2	6	46.15

Table 1 : Confusion matrix of Naive Bayes Classifier

The overall accuracy obtained using Naive Bayes Classifier is 44.26%. As observed from the table above, classifier seems to be particularly performing well for heart shaped faces and has performed poorly for round shaped faces. Naive Bayes classifier is best suited for training if the data set is small.

B Confusion matrix for MLP

The performance of multilayer perceptron is illustrated in Table 2. The overall accuracy of multilayer perceptron obtained is 40.98% .One of the major reason for multilayer perceptron is performing less accurately when compared to Naive Bayes classifier is that the amount of data used of training the classifier is very small and since Naive Bayes classifier considers each feature used for training independent of other, it is performing better than multilayer perceptron.

Face Label	Predicted Label					Accuracy (%)
	Heart	Oblong	Oval	Round	Square	
Heart	3	8	1	0	2	30
Oblong	1	1	0	0	0	6.25
Oval	1	0	7	4	2	58.33
Round	3	2	1	6	1	60
Square	2	5	3	0	8	61.55

Table 2 : Confusion matrix of Multilayer perceptron

C Confusion matrix for KNN

Face Label	Predicted Label					Accuracy (%)
	Heart	Oblong	Oval	Round	Square	
Heart	10	4	1	1	2	100
Oblong	0	8	1	0	3	50
Oval	0	3	9	2	2	75
Round	0	1	1	7	2	70
Square	0	0	0	0	4	30.77

Table 3 : Confusion matrix of k- Nearest Neighbor

Table 3 illustrates the confusion matrix obtained for k nearest neighbor classifier. The overall accuracy obtained is about 62.3% and like Naive Bayes classifier, it has performed very well for heart shaped faces. Table 4 illustrates the performance of all the three classifiers.

Algorithm	Accuracy(%)
Naive Bayes Classifier	44.26
Multilayer Perceptron	40.98
K-Nearest Neighbor	62.3

Table 4 : Accuracy of classifiers used

5 CONCLUSION & FUTURE WORK

In this paper we propose a solution to recommend hairstyles to users based on their face shape. The approach used can also be extended to recommend beard styles, sunglasses and various such things. Accuracy obtained in this paper is average. This accuracy can be improvised by considering few more correctly labeled images for training the classifiers. The desirability attribute can be extracted from social networking websites to provide better recommendations which would not be subjective as it is in this case. It can also be extended to recommend hairstyles for a particular event.

6 REFERENCES

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