

# Design and Implementation of Hair Recommendation System Based on Face Recognition

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**Abstract**—Based on the introduction of face recognition technology and hair style recommendation algorithm, this paper proposes the overall design and implementation of the Hair Recommendation System Based on Face Recognition platform. The software comprehensively considers the hair length, hair volume, face shape and other factors, through the camera to achieve parameter acquisition, face recognition, facial features sampling for hair style recommendations. The software solves the problem that people can't get the expected shape because they can't analyze their hair and facial features correctly when they are getting a haircut, so that people can have a more intuitive visual experience while implementing hair style description. The choice of hair style needs to provide a complete solution for the hair industry marketing and personalized customization services, and help the hair industry to transform and upgrade. Compared with other test-making software, the hair recommendation system introduced in the article incorporates a scoring recommendation algorithm, which can recommend the appropriate hairstyle to the user according to the current aesthetic priority. Therefore, it has new features, new forms and new audiences.

**Keywords**—hair style recommendation; face recognition; deep learning; software development

## I. INTRODUCTION

With the continuous development of technology, face recognition technology has been more and more widely applied to human life. Such as: home security, meeting attendance, electronic documents and so on. However, these applications can only extract the facial features of a person and compare them with data and judge whether they are the same. It is also difficult to synthesize a large number of facial features to get the answer of "what is fashion". In this paper, we will explain how to analyze the current fashion trends by processing a large number of models' facial images, and design algorithms to recommend suitable hairstyles for people with different facial features. The system aims to study and explore a hair styling technique for different face types and hair features by utilizing methods and techniques for deep learning face recognition. The most important part of the software is the face recognition and hairstyle recommendation algorithms. Face recognition is a technique for identifying people based on facial feature

information of a person. We use the camera to capture the user's static frontal photos, and then perform a series of related operations such as face recognition on the detected faces. We will use this technique to extract and analyze facial and hair features. Then, according to the matching relationship between the face and the hairstyle, a combination recommendation algorithm specially designed for the hairstyle is used to recommend a suitable hairstyle style for the user intelligence. Finally, the virtual tryout of the hairstyle can help the customer to select the appropriate hairstyle. Users can see the final presentation of the hairstyle before the haircut, and achieve effective communication between the user and the hairdresser.

## II. SYSTEM DESIGN

### A. Overview

For ease of use, the system is divided into two parts: the client and the server. The client is an Android application installed on the user's smartphone. It is mainly responsible for the collection of the front photos of the user, the recommendation and presentation of the hairstyle, and the server is mainly used for the development of the training for face recognition in the early stage, and the optimization of the parameters for the matching of the hairstyle and the face.

### B. Architecture Design

The operating system of the entire system is as follows:

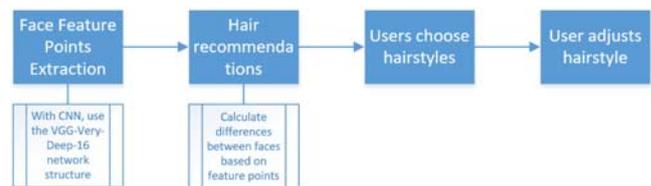


FIGURE I. ARCHITECTURE DESIGN

### C. Selection of Face Recognition Algorithm

At present, the accuracy of the face recognition algorithm is affected by many factors, such as background, expression, lighting conditions and other factors, and these factors will make the face image significantly different. In order to

eliminate the influence of these factors on the recognition effect, our usual practice is to select a larger training sample to collect various lighting and posture situations. Or by establishing a 3D model of the face, estimating the influence of illumination, tracking changes in key feature points of the face, estimating pose parameters, and changing the influence of the pose by means of elastic map matching.

A human face is a complex surface that contains a variety of information. This information is often not in a plane. A lot of this information constitutes a three-dimensional coordinate of the face. Starting from the basic face of the face, a limited type of face database can be obtained by manually calibrating the three-dimensional model in the three-dimensional face database and determining its face shape. According to the convolutional neural network algorithm, different types of face data are trained to obtain the optimal solution of the corresponding parameters. When matching, according to the structural proportional relationship of the face shape obtained from the face database, a rough match is made, the face shape is determined, and then the detailed matching is performed in the face database of the type. This project uses Vggface face recognition network, adopts VGG-Very-Deep-16 network structure. The first five layers are composed of convolution layer and pooling layer alternately, followed by two fully connected layers. And the final classification of the softmax layer. After inputting an image, the output of the first fully connected layer FC6 is used as a face feature for other target recognition classification tasks. The purpose of the face features extracted by Vggface and the features extracted by the proposed algorithm are to compare the similarity of two faces. Therefore, the Vggface feature description can be used in the recommendation algorithm of this paper.

As shown in Figures 2, the VGG network structure has higher accuracy and lower network power consumption than other network structures. Therefore, this project selects VGG16 as the network structure.

Method	top-1 val. error (%)	top-5 val. error (%)	top-5 test error (%)
VGG (2 nets, multi-crop & dense eval.)	23.7	6.8	6.8
VGG (1 net, multi-crop & dense eval.)	24.4	7.1	7.0
VGG (ILSVRC submission, 7 nets, dense eval.)	24.7	7.5	7.3
GoogLeNet (Szegedy et al., 2014) (1 net)	-	-	7.9
GoogLeNet (Szegedy et al., 2014) (7 nets)	-	-	6.7
MSRA (He et al., 2014) (11 nets)	-	-	8.1
MSRA (He et al., 2014) (1 net)	27.9	9.1	9.1
Clarifai (Russakovsky et al., 2014) (multiple nets)	-	-	11.7
Clarifai (Russakovsky et al., 2014) (1 net)	-	-	12.5
Zeiler & Fergus (Zeiler & Fergus, 2013) (6 nets)	36.0	14.7	14.8
Zeiler & Fergus (Zeiler & Fergus, 2013) (1 net)	37.5	16.0	16.1
OverFeat (Sermanet et al., 2014) (7 nets)	34.0	13.2	13.6
OverFeat (Sermanet et al., 2014) (1 net)	35.7	14.2	-
Krizhevsky et al. (Krizhevsky et al., 2012) (5 nets)	38.1	16.4	16.4
Krizhevsky et al. (Krizhevsky et al., 2012) (1 net)	40.7	18.2	-

FIGURE II. COMPARISON OF NETWORK STRUCTURE RESULTS[1]

#### D. Recommendation Algorithm Design

The hair style recommendation of this project mainly compares the feature points of the face input by the user, compares the Euclidean distance between the feature points with the data in the database, and finds the database face with the highest similarity with the user input face, and considers the database. The face hairstyle is the most suitable for the user, that is, the face recommended to the user. In recent years, deep learning methods have made rapid progress in the field of

computer vision, especially in the detection and identification of targets, which has led to a wave of deep learning. Convolutional Neural Network (CNN) is a network model in deep learning technology. It consists mainly of convolutional layer, pooled layer and fully connected layer. It performs convolution and pooling operations on local areas of images. The local features of the image that can be extracted, and the convolution and pooling operations for all the local features can obtain the global features of the entire image. CNN fully exploits the features contained in the image through local perceptual regions of image space, neuron weight sharing, etc., and abstracts the extracted local features step by step through the convolution-pooling layer connected by layers. Global features and high-level semantic features, as shown in Figure 3, complete the classification task. This project will use the VGG-Very-Deep-16 network structure in Vggface to extract the facial feature points and calculate the facial features in the face, the facial features, the facial features and other information, compared with the facial features of the models in the database. Yes, and the hair style of the most similar model of the facial features is output, and the hair style is recommended.

The specific facial features include the center of the two eyes, the length of the left and right eyes, the distance between the inner corners of the eyes, the distance between the eyebrows and the eyes, the width of the face, the length and width of the nose, the length and width of the mouth, the distance from the eyes to the nose, and the nose to mouth. the distance.

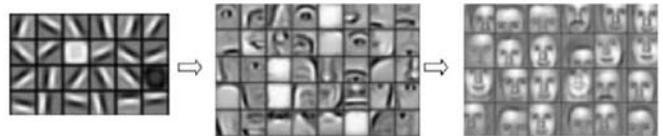


FIGURE III. LEARNING PROCESS OF CNN

### III. SOFTWARE DEVELOPMENT IMPLEMENTATION

The development and implementation process of this project is mainly divided into two parts, one is the selection, construction and training of CNN network structure, and the second is the development of Android interface and the construction of server.

CNN selects the VGG-Very-Deep-16[2] network structure in Vggface, and the development environment is pytorch. pyTorch is a python-based scientific computing package that can be used to calculate the performance of the GPU with sufficient flexibility and speed. The specific work during development includes the selection of face image data, the extraction of face image hairstyle, the training of neural network, and the implementation of recommendation algorithm[3].

The Android development environment is Android API 28. Mainly used to interact with users.

The training effect of the CNN is as shown[4] in the figure below, wherein FIG. 4 is an input test image, and FIG. 5 is an image of a face feature point outputted after the operation. The

running effect of the Android interface is as shown in the following figure, wherein FIG. 6 is the original image of the model, FIG. 7 is the hairstyle recommended by the system for the model, FIG. 8 is the image input by the user, and FIG. 13 is the image recommended by the system for the user. The recommended hair style of the system was evaluated using a visual evaluation method and a color value quantification system[5]. The test results show that the face development scores after using the system to change the hairstyle are improved.



FIGURE IV. INPUT IMAGE



FIGURE V. OUTPUT IMAGE



FIGURE VI. MODEL IMAGE



FIGURE VII. MODEL RECOMMENDATION IMAGE



FIGURE VIII. USER IMAGE



FIGURE IX. USER RECOMMENDATION IMAGE

#### IV. SUMMARY

Face recognition is a hot research topic in the field of machine learning. Hair style is an important indicator affecting the value of the face, which has an important impact on people's work and life. But people tend to be confused about what kind of hairstyle is right for them. This project proposes a hair style recommendation algorithm by studying the relationship between facial features and hair style. Firstly, the face data set is collected, the image is preprocessed, the facial features of the face are extracted, the recommended hairstyle is obtained according to the recommendation algorithm, and then the face is combined with the recommended hairstyle to obtain the face after the hairstyle is replaced.

After inputting the original picture input by the user and the picture after replacing the recommended hairstyle into the third-party value evaluation website, the project finds that the picture using the recommended hairstyle often obtains a higher face value score. Through comparison of multiple sets of experiments, it is proved that the hair style recommendation algorithm has a good effect, but the hair style recommendation is a very complicated process. The manual recommendation still needs rich experience, not to mention the virtual recommendation. Therefore, hair style recommendation is still a challenging figure and work. Although there are some methods in the field, these methods are not used for hair style recommendation, so the hair style recommendation method is not completely accurate.

#### A. *Insufficient and Prospects*

Although the hair style recommendation method of this project has achieved certain results, there are still some shortcomings and problems:

Firstly, in the hair style recommendation algorithm, the hair style data collection is not perfect. People's hair styles are varied, and only a part of the hairstyles are collected in this project.

Secondly, in the recommended algorithm, factors such as hair volume and hair quality are not considered, which may result in an unnatural hair style.

Thirdly, after recommending the hairstyle, directly attach the hairstyle image to the input image, which may cause some final results to be distorted.

For the shortcomings of this project, we can do more in-depth research in the following aspects:

First of all, the GAN neural network can be used to combine the recommended hairstyle with the user image naturally to avoid distortion. Second, you can add hair style, hair volume and other factors as input to recommend hair style.

#### ACKNOWLEDGMENT

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