HAIRSTYLE RECOMMENDATION BASED ON FACE SHAPE USING IMAGE PROCESSING

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Abstract- Hairstyling is an art of fashion transformed since ancient era, with the influences from many diverse factors. It has been a primary aspect of human lifestyle and society in various different ways with the growth of research fields like modelling human, visual searching, visual matching, facial verification for security measures and etc. Perfect hairstyle improves specially a woman's self-confidence. This paper presents a hairstyle recommendation system based on face shapes and suitable hairstyle with expert's knowledge for the face shape derived from face shape classification algorithm. Recommendation algorithm has developed base on the learning relationship between facial shapes and suitable hairstyles. This research has classified face shapes into 5 different shapes: round, oval, oblong, square, and heart. Here, machine learning libraries were used to detect the landmarks of a face image in face shape identification process. The accuracy of our face shape identification algorithm is 85% out of 100 images. After identifying the shape of the face, the recommendation system proposes suitable hairstyles for the face image. Here, have used Python programming language and image processing techniques to develop the algorithm. The system will allow users to upload a preferred face image, process it and will automatically select the matching hairstyles category for the given image. The empirical study of our prototyping system has proved the effectiveness of our recommendation algorithm.

Keywords- Face Shape, Facial Feature, Hair Styling, Image Processing, Landmark Detection

I. INTRODUCTION

The hairstyle is one of the most important aspects of people in determining their appearance and mood. People look completely different by changing their hairstyles. Most one deeply cares about their hairstyles not only women but also men's. The Hairstyle can make human appearance attractive or unattractive. If someone chooses an inappropriate hairstyle, then it gives a bad looking and loses confidence.

A hairstyle mean is styling hair on the human scalp. Hair gives various fashionable styles to a human's body. Which is main aspects of the human body although without hair become an unnatural but also without hair is a new hairstyle to humans. The increase of fashions most people think of hair as their main important thing.

Many people prefer to choose their hairstyles from magazines, internet without knowing which one is realty suits their faces. If woman's hair cut too short, it takes a long time to enough grow for doing new hairstyle. Therefore, before going to the salon it will better choose suits hairstyle to our face. Sometimes our selected hair styles do not match to our face. A beauty expert says that a proper hairstyle for someone depended on their face shapes. It is better to know our face shape and features well before doing hairstyles. Similar face shapes have similar hairstyles. Therefore it is better to have hairstyles recommendation system to know about hair styles before

doing hairstyles. A face shape classification is essential for the development of a hairstyles recommendation system.

Several commercials software has been developed for allowing users to simulate how they look with different hairstyles by manually changing. Other researches use face modelling techniques for face detection and face recognition works. The major objective of the work is a proposed method to recommend the hairstyles based on major face shapes with a combination of hair expert's knowledge. One of significance in the proposed methodology mainly concern on image processing techniques to detect face shape rather than using other AI techniques. The proposed classification algorithm is to classify the face shapes into five shapes oval, oblong, square, round and hart.
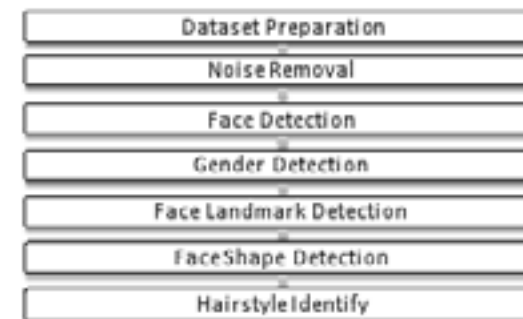
II. METHODOLOGY AND EXPERIMENTAL DESIGN

Figure 1. Overview of methodology

A. Data Collection

Collected information about hairstyles, hair features and face shape from magazines, websites and person who expert about the hair. Mainly target the salons in the various places in Sri Lanka for collet the hairstyles information and other facial features. Basically, salon owners think about customers and event type before making hairstyles. Both male and female features and hair styles are different. We have chosen face shape and facial features information to identify the matching hairstyles.

We have collected a large face dataset that contains hairstyles images under the unique categories such as

hair types (straight, wavy, curly) and further categorized as male and female as well. Each of those categories we collected more than 1000 images. There are five face shapes, rounded, oval, and squared and heart.

B. Face Detection

To identify the faces we use the Haar Cascade classifier in the OpenCV. A Haar-like feature considers adjacent rectangular regions at a specific location in a detection window, sums up the pixel intensities in each region and calculates the difference between these sums.

C. Face Landmark Detection

Face Landmark detection is most the important part when it comes to face shape identify. In order to detect face landmarks, the Dlib machine learning library was used, which is written in the C++ library. The OpenCV/ C++ library was used for python, there is an API support for python.

Features of all images were extracted by landmark detection. Figure 2 shows the identified eyebrows, eyes, mouth, chin and all 67 points in the face. But, there were no any defined coordinate points which separate a forehead and the hair. Researching about face, it would help to find other points in the face. After finding all points in the face, we have generated the algorithm to find the face shapes.

To identify the Figure 3 shown points, the researchers have used thresholding techniques to separate the forehead from the hair. Before use thresholding techniques it is better to make an image as a grayscale image. The input image consists of with three color channels. Where contains Red, Green and Blue channels. It's easy to do threshold processing by converting those three channels into a single channel. In order to make that happen here, we used a gray scaling method in OpenCV.

After converting the image into a grayscale image, There have tried on simple thresholding methods like Binary, Binary inverse thresholding, To Zero thresholding likewise. The most complex task was to the identify threshold value because the documents have different colors and when the scanning, pixel luminance may change. To overcome the problem research use the

adaptive thresholding Otsu method. Since researches are trying to make binomial images along the process we are doing and it is the best input to Otsu thresholding because of Otsu thresholding algorithm find the Bimodal values and try to find the threshold that minimizes the weighted within-class variance.
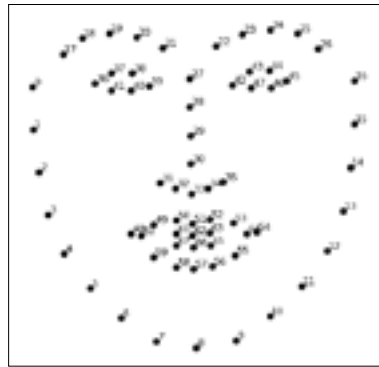
D. Identify Face Shapes

Figure 2. facial landmark points identified on face

In order to find the face shape, there are several calculations have done. Table 1 denotes what are the parameters take part in the proposed face classification calculations.

Figure 3. The extra coordinate values which need to identify

Table 2 shows the face shapes and its condition with face length and angles. In order to make those conditions the knowledge gain from previous researches as well as experts in the industry and other studies related to face modelling is used.

E. Select the Hairstyles

The hairstyles are categorized for relevant face shapes. Face Shapes have different hairstyles. According to the expert's knowledge hairstyles are stored in the database base on the face shapes. After identifying the face shapes, the system finds the matching hairstyle from the database.

Table 1. Calculated lengths and angles on image

Coordinate points	Description
68-8	Face Length
70-69	Forehead Length
8-3	Jawline Length
10-6	Chin Width
26-17	Cheekbone Width
1-4	Angle a1
4-6	Angle a2
6-8	Angle a3

Table 2. Condition for the face shapes

Face Shape	Condition
Heart	Forehead Width > Cheekbone Width > Jawline && a1>a2>a3
Oblong	Face Length > (Cheekbone Width ≈ Forehead Width ≈ Jawline) && a1 ≈ 90>a2>a3
Oval	Face Length > Cheekbone Width & Forehead Width > Jawline && a1 ≈a2≈a3
Square	Face Length ≈ Cheekbone Width ≈ Forehead Witch ≈ Jawline && a1 ≈ 90>a2 ≈ a3
Round	(Face Length ≈ Cheekbone Width) > (Forehead Width ≈ Jawline)

III RESULT

The system result is evaluated in two ways. First, the researches evaluate the image face shape using 100 images. Second, the 50 volunteer women and 50 men who were undergraduate students evaluate the system. Prior to the undergraduate evaluation, the researchers explained a guideline how to determine their face shapes. Then the users were asked about their face shapes. The system by answering a questionnaire. The questionnaire was divided into 3 assessments as follows.

A. Researches Evaluation about algorithm

In the system basically the head top point 68 (e.g. Figure 4) different with some factors. For using 100 images we evaluated the point correctness in the system. The accuracy of head point (68) identification algorithm is 75 % of 100 images.

Figure 4. Example on finding all the landmarks detecting

And then researches evaluate the face shape accuracy. The researchers used 100 images which were already know their face shapes. We used 20 images are oval faces, 20 images are round faces, 20 images are heart faces,20 images are oblong faces and 20 images are square faces from the 100 images for evaluating the algorithm of face shape accuracy.

Table 3. Face Shapes Classification

Face shape	Identified face shape
Oval	17
Oblong	15
Square	20
Heart	16
Round	18

The system accuracy of identify oval face shape is 85% , Oblong face is 75% , Square face is 100% , Heart face is 80% and round face is 90%.The result shown in Table 3.

B. System Evolution

System evolution was done by the undergraduate. Prior to the evaluation, the researchers explained a guideline how to determine their face shapes. Then the users were asked about their face shapes. The system by answering a questionnaire. The questionnaire was divided into 3 assessments as follows.

1. User Interaction Assessment System Overview

    The user evaluated the system on (i) an ease of use (ii) a user interaction (iii) an interface design (iv) contents available in the system and (v) a chance of using the system again in the future. The five-level Likert principle to measure the assessment, defining as highest (5), high (4), medium (3), low (2), and lowest (1).

2. Performance Assessment

    To evaluate a performance on (i) a satisfaction of the face shape classification results and (ii) an ability to face shape feature point detection as shown in Fig. 8. Again, the Likert scaling was applied for this assessment.

    The users were asked to determine their face shapes before using the system and the system's prediction matched with the answer given by 40 women out of 50 and 43 men out of 50. It should be noted that the users were not beauty experts and had limited knowledge and experiences to determine face shape.

3. Hairstyle recommendation assessment

This assessment comprised of a satisfaction of (i) recommended hairstyles and (ii) hairstyle's simulation. Above 5-level Likert scale was used for assessment the recommendation system. According to the result, the system achieved more than four out of five in most of the cases, except the satisfaction of hairstyle's simulation and except an ability to face shape feature point detection.

The evaluation was not implemented in a control room but in different environments and uploaded images get from user devices such as mobile phones, different Cameras and etc. Since the feature point detection was poor this could lead to the poor hairstyle simulation performance.

IV. DISCUSSION

Hairstyle suggestion using image processing is a new area where much research has not been taken. The proposed system has used some new techniques to suggestion Hairstyles and identify face shapes. The system has been tested with a wide variety of different color and resolution images.

This research has done only for color images and aligned images. The failure case is without using aligning images which are difficult to detect faces and give less accuracy for identifying face shapes. Also, the face image's forehead contains without hair, which hiding the research head point feature.

Uploaded images got from users. Those images contain different noise types and lighten, which have given less accuracy of features landmark detection. The images whose values are confined to some specific range of values only. For brighter image will have all pixels confined high values. But a good image will have pixels from all regions of the image. Therefore, we applied histogram equalization improves the contrast of the image. The median filter is used to remove the different types of noises.

Open CV image processing technique selected 60 points in an image of a face that outline the features of the face clearly. Unfortunately, these points did not include the forehead, hence we were not able to identify the top of the face using this algorithm In order to identify a point indicating the hairline. So we have to design an algorithm using Otsu thresholding techniques. This technique does

not find points outlining features well, but it can give a good point for separating hair from the forehead, so it was able to find a hairline position.

There were some problems when it comes to identifying the shape of the face. Users are noted beauty experts and they do not have a clear idea about the shape of the face. Even though they found their face shape according to the guidelines given. But it conflicted when it comes to testing using the software. Overall identification of user face shape accuracy of the software was 85%, which percentage proved the accuracy of face shape identification of our system.

Hairstyles gathered from different databases, websites, magazines and beauty experts. The hairstyles categorized for face shapes according to the details of beauty experts, Hong and Derrick.

In the result evaluation phase of the system, the user satisfaction of hairstyle suggestion got 90% percentage. The system can identify face shape more than average 4.00 out of 5.00. It is a good result of this system

In this result evolution, the feature point's detection assessment was at more than average 4.00. The evaluation was not implemented in a control room but in different environments. The feature point detection was poor this could lead to the poor hairstyle simulation performance.

This system can use again the future, according to the evaluation result. Because of that, this system is most important for any generation. They hope to do hairstyles with different hairstyles using that kind of recommendation system.

V. CONCLUTION

The hairstyle recommendation system was presented in this paper. The system classified the user's face shape into five categories which were suitable for hairstyle recommendation. The hairstyle recommendation rules were based on beauty experts' suggestions. Moreover, the system ranked proper hairstyles in the database according to their relevant details. The researched evaluate the face shape accuracy using 100 images. The overall face shape accuracy is more than 80%. It is proving that this system can identify the face shapes very well. The system was

evaluated by volunteers on three assessments, including user an interaction, a system performance, and a satisfaction on hairstyle recommendation by the system. The average of three assessments was at 4.05 out 5.00. This is the valuable recommendation system is proven by the assessment of the users. Hairstyles can give value to the human appearance. Many people interact with these kinds of recommendation very easily. This hairstyle recommendation gives various hairstyles to the user and also there have some limitations. Those limitations are can develop with the future works.

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