Pocket Fashionista - a Complexion based Outfit Color Advisor using Neural Networks

submitted in partial fulfillment of the requirement
for the award of the Degree of

Bachelor of Technology
in
Computer Engineering

by

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October 2020

Certificate

This is to certify that the Project entitled "Pocket Fashionista - a Complexion based Outfit Color Advisor using Neural Networks" has been completed to our satisfaction by Mr.Siddesh Sonawane, Ms.Anisha Gharat and Ms.Tejashri Wagh under the guidance of Prof. Reeta Koshy for the award of Degree of Bachelor of Technology in Computer Engineering from University of Mumbai.

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Project Approval Certificate

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Statement by the Candidates

We wish to state that the work embodied in this thesis titled "Pocket Fashionista - a Complexion based Outfit Color Advisor using Neural Networks" forms our own contribution to the work carried out under the guidance of Prof. Reeta Koshy at Sardar Patel Institute of Technology. We declare that this written submission represents our ideas in our own words and where others' ideas or words have been included, we have adequately cited and referenced the original sources. We also declare that we have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in our submission.

Name and Signature:
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3. Tejashri Wagh

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Contents

List of Figures

List of Abbreviations

CNN	Convolutional Neural Networks
RGB	Red, Green, Blue
HSV	Hue, Saturation, Value
YCbCr	Luminance, Chrominance
ResNet	Residual neural network

Abstract

Fashion is a popular aesthetic expression at a particular time, place and in a specific context, especially in clothing. We dress up everyday in different outfits and good outfits boost our confidence. Thus wearing suitable outfits adds a lot to our personality. However when we shop either in a store or online, we try to follow the ongoing trends and some people are also influenced by a certain fashion enthusiast or a fashion blogger. But there is always a case where we get the perfect T-shirt with the most wanted color and style but can't match the pants with that color or style, or the cloth color does not match your complexion but it did match the model's skin tone who is advertising it.

Sometimes we just need to select some outfit from our wardrobe to wear, but are confused with selecting the suitable color combinations which will match our looks and complexion. We are even indecisive about what to wear based on the ongoing weather or season. While buying clothes online we don't get to try on clothes that we are buying so as to understand how will they look on us. The conventional inventions are focused on the coordination or sale of the product while the user directly dresses, and thus does not really help users who lack color sense or do not fully utilize the clothes they own. It would be advantageous to have a system which will give personalized outfit recommendations to users based on their complexion, the ongoing weather and also provide a virtual try on facility.

This research work is concerned with providing a solution that provides a personalized experience to users by giving them the best recommendations that will make them look and feel the best. It also allows the users to virtually visualize how they will look in the recommended color combinations. The virtual trial room gives a live video demo of the clothes on the user's body. The application allows the users to make the best choices with their clothes color combinations and thus will save their time and energy in even trying out the clothes. Another important thing this system provides is the clothes and color combination recommendations based on the ongoing weather and seasons so that he/she can follow the latest trends according to the ongoing weather and get the best outfits that are comfortable to them. It also provides more similar recommendations of outfits based on the user's choices and interests.

This system will facilitate merchants to master the real-time demand of consumers. Also the system has wide applications to be inculcated in real time shopping and E-commerce websites. The system emphasizes skin tone detection and classifies it into different Indian skin color tones and based on that it will recommend the best color clothes to that particular skin tone. Thus it can serve as a personal fashion advisor for the user.

Chapter 1

Introduction

This work is concerned with the issues that indecisive people have regarding the outfits they should wear or buy or which fashion trends to be followed. The scope of the problem as follows:

- To recognize the user's skin complexion from an image.
- To recommend perfect color combinations on the identified skin complexion.
- Improving the accuracy of outfit fitting the body.
- To recommend suitable outfits accordingly to the weather conditions or seasons.

Whenever we go shopping either be it a store or online, we do follow the ongoing trend of being a fashion enthusiast. But there is always a case where we get the perfect T-shirt with the perfect color but can't match the pants with that color, or the cloth color does not match your complexion but it did match the model's skin tone. Or we just need to change our wardrobe, but are confused with selecting the suitable color combination which matches with the user's looks and skin type.

This thesis presents a new idea to overcome the above difficulties in the form of 'Pocket Fashionista'. So the solution to this is a system which recommends the user a list of color combinations according to the user's skin tones. The model especially focuses on Indian skin tones. It can be a personal fashion advisor on the basis of user's complexion. The user will upload one of his pictures and the face detection algorithm detects the skin colour of the user. Algorithms will match the skin colour within the skin colour meter and recommend the best possible colour combinations.

The system can also suggest the best color and outfit combinations according to the surrounding weather and in accordance with it the intelligent recommendations will be provided. Color plays a very important role in coordination, and even the same clothes may have different images depending on color matching. However, the conventional invention is focused on the coordination or sale of the product while the user directly dresses, and thus does not really help users who lack color sense or do not fully utilize the clothes they own.

So we also plan to make a virtual trial room where after suggesting the color combinations of various outfits, it will display the outfit of the recommended color on his body when the camera is faced towards the user. This project recommends the colors and outfits to a user which is personalized for that specific user. The

never ending confusion of matching color to make it a perfect outfit can be solved through this process. The below Fig. 1.1 shows a working block diagram of the system

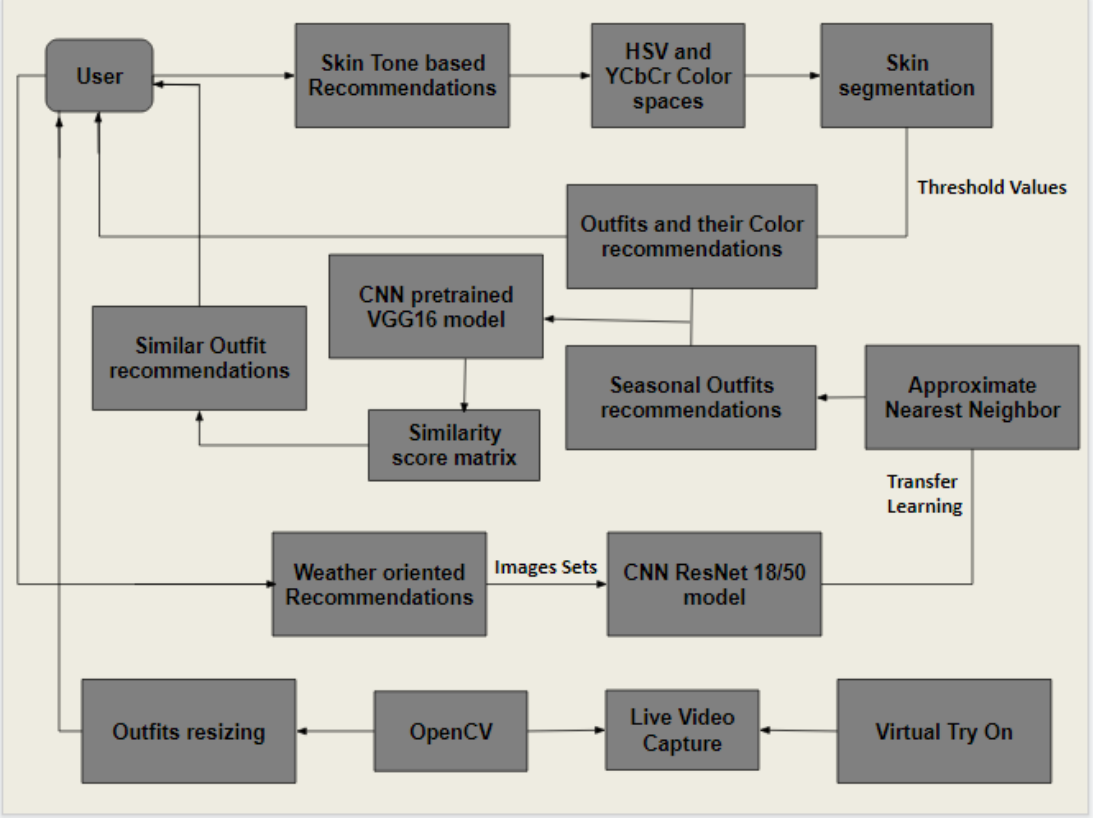

Figure 1.1: Pocket Fashionista - Block Diagram

1.1 Motivation

This work is motivated by the need of recapturing the essence of Fashion. Another point of motivation is the need of various indecisive people about fashion and outfits and their constant confusion in the selection of suitable color of outfit. The system recommends the most suitable outfits and their colors to such users that will suit their complexion the most.

Also, there exists a lot of perplexity among people in figuring out the most perfect outfits just by looking at the photos on social media or any other E-commerce platforms. So the work proposed in this thesis also provides similar clothing recommendations to the user based on their interests thus making their recommendations more precise.

1.2 Objectives

The system has the following objectives:

- To provide the most suitable color combinations.

- To study current consumer trends and identify target demographics.
- To promote an understanding of fashion and outfits.
- To minimize the time and energy required to select among various options and try it on mobile screen.
- To provide a personalised experience in relation to variable factors like weather.

1.3 Problem Statement

People usually find it difficult to get the best clothing color combinations that suit their skin tone well and go well with the existing fashion trends. The aim is to develop a complexion based outfits and clothing color recommendation system that will help to choose the best possible clothes and their color combinations based on their complexion. It will also allow the users to virtually visualize how they will look in the recommended clothes.

The users are to be given recommendations based on the ongoing weather conditions and seasons as well. To give a personalized experience to the user the aim is also to provide outfit recommendations that suggest similar styles as per the user's interests and requirements. The application allows users to make the best choices with their clothes color combinations, thus saving their time and energy in even trying out the clothes. It is easy for merchants to master the real-time demand of consumers.

1.4 Contributions

The system will contribute a lot of value to the online shopping businesses, E-commerce websites and various small businesses as well. Individual sellers can also opt for the system to set it up in their stores. People will get a better choice of outfits and apparels thus saving time and wipe out indecisiveness and gain a confidence level.

1.5 Layout of the Report

A brief chapter by chapter overview is presented here.
Chapter 2: A literature review of different real-time recommendation methods for outfits and their color combinations is presented.
Chapter 3: Experimental setup and the overall design of the system is presented in this section.
Chapter 4: In this chapter, the most essential information on the implementation of the system models with the basic equations for the different modules are presented.
Chapter 5: The results obtained from all the modules are discussed here.
Chapter 6: Some of the important design issues of the existing systems will be highlighted in this chapter. Also how the proposed system is a better alternative will be the focus of this chapter.
Chapter 7: Here points like what more additions can be made in the system and

what else can be included and developed in this system are discussed.

Chapter 2

Literature Survey

Many people find it difficult to get the best possible colour combinations of their clothes in their day to day life. While shopping online many people get confused while selecting the clothes. In such cases, there is a need for assistants that can intelligently recommend clothes to the users along with the different colour combinations that can perfectly suit the user's profile and give a personalized recommendation to the user.

In context with this issue, many systems have been developed to provide personalized recommendations to the user. In [1], a recommendation system for clothes based on Season, occasion, posture and skin colour is proposed. Here recommendations are based on personalised clothing styles according to fabric styles and colours. A broad classification of the personalized indicators for recommendation makes this work remarkable. Also a simple mobile interface which is provided to the user gives an optimal solution. User preference is also given importance in certain works such as giving recommendations from the users closet or the wishlist[8].

Another few approaches go with the users input that is taken into consideration for providing recommendations. Knowledge graph technique is used for such implementations wherein it constructs knowledge graph of the user, clothing and context. The Apriori algorithm is used here to capture the intrinsic correlations between clothing attributes and also the context attributes[4]. It makes the recommendations that are most similar to the user's clothes by calculating the similarity of clothing ontology. This also improved the accuracy and efficiency of the recommendations made. Also, some research works made recommendations that were particularly suitable to a particular user as per his/her personal preferences, his/her history of purchasing clothes. It is also based on his/her previous evaluation of the system[5].

An improved approach which gives a really personalized recommendation system is where users are prompted to provide their photos so as to give recommendations based on their facial features and skin tone that suit them well. Skin segmentation technique has powered this system[9]. Providing weather based suggestions for apparels is a challenging task to be achieved. The user is given personalized recommendations based on the ongoing weather so that he can feel both comfortable and trendy in any weather that is going on[6].

Virtual trials of clothes have gained importance over the years. This not only helps to visualise how the clothes will look on the user's body but also helps to save the user's time in trying out the clothes[2][7]. Basically image warping techniques are

used for solving this problem. Fitting the clothes to 2D or 3D models is achieved by Warping techniques. Complexity of the model's pose and even in the scenario where the body parts can overlay over the clothes are well overcome in such solutions[2]. Event based recommendations are given to the user so that he can get proper fashion tips which he can follow to impress his social circle[3]. This makes him confident to attend the social events by following the latest fashion trends via a small personal fashion advisor.

The primary objective of Pocket Fashionista is to provide personalized outfit recommendations to the user.

2.1 Characteristics of Recommendation Systems

Recommendation Systems help to determine the user's interests based on his profile. They do an analysis of whether an item will be chosen by the user or not. They save the user's time and cost of searching and selecting content based on his/her interest specifically in online shopping platforms and E-commerce sites. They add a lot of market valuation to such online businesses and enhance their revenues. Thus personalized content is provided to the users through a large volume of data [3]. This helps the users to get the best products when they have very less or negligible knowledge of the subject. They are beneficial to both the users and the merchants.

They have improved the decision making abilities of consumers thus giving them the suggestions to buy only the quality products [7]. Techniques like Collaborative filtering, Content-based filtering and Hybrid filtering are used for building such recommendation systems.

Chapter 3

Design

3.1 Skin Tone based Outfit Color recommendations

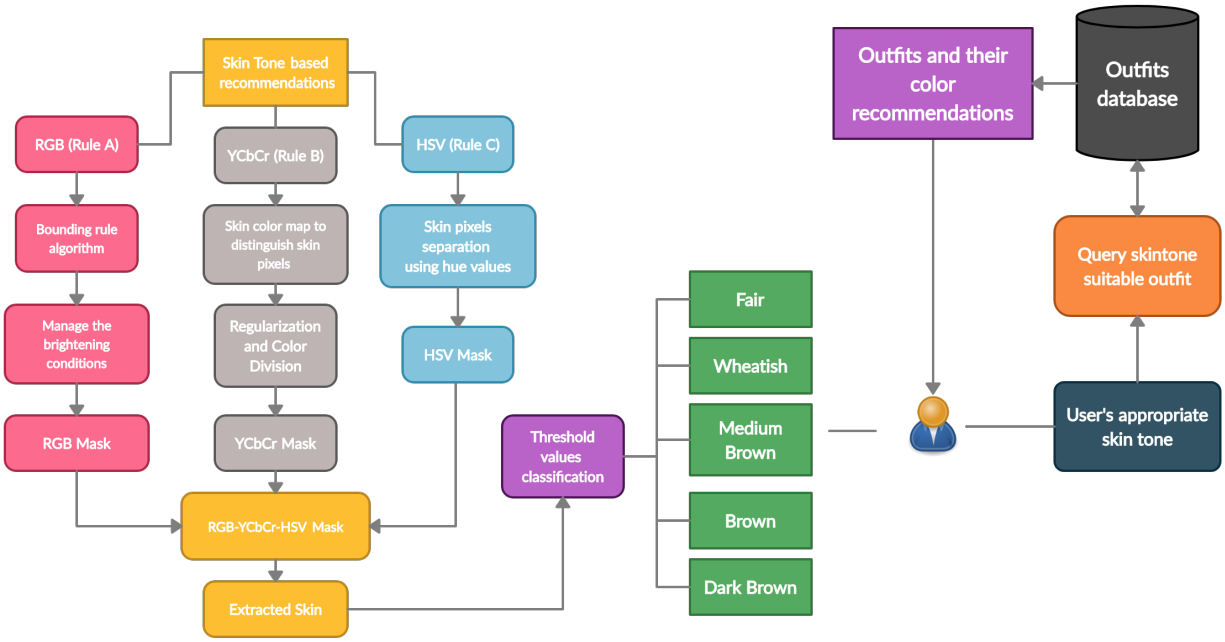

Figure 3.1: Skin Tone based recommendations

Fig. 3.1 shows that for the Complexion based outfit recommendations, we have used a blend of the three rules - RGB, HSV and YCbCr rules. Initially, each of these rules have been implemented separately to obtain their respective skin masks. After this a mask of RGB-HSV-YCbCr is obtained to gain a better accuracy in the skin extraction process. The skin tone classification into Indian skin tones is done by the threshold ranges. Lastly, as per the appropriate tone of the user, Outfits and their colors are dynamically recommended to the user.

3.2 Weather oriented Outfit Recommendations

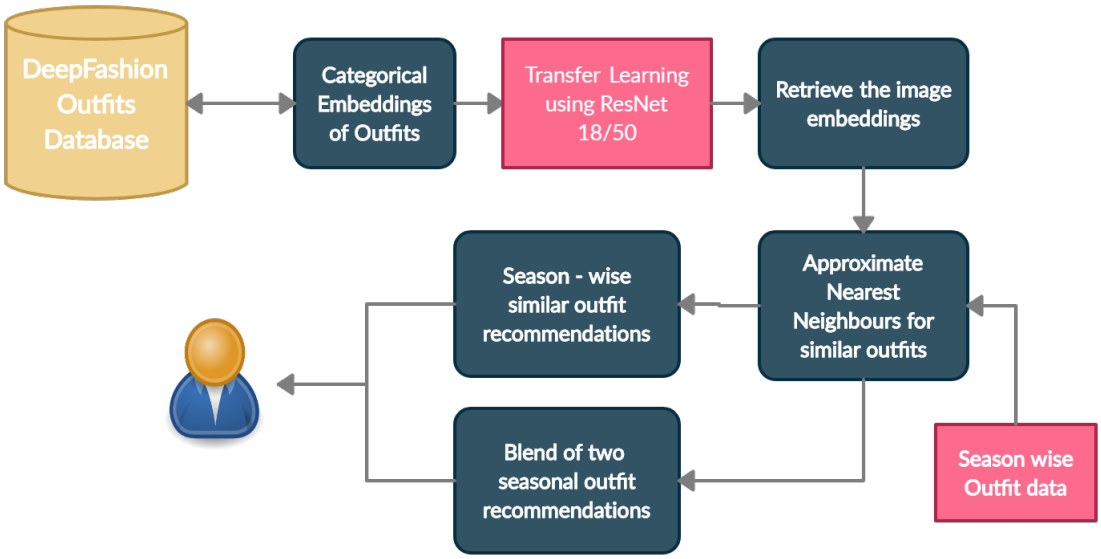

Figure 3.2: Weather oriented Outfit Recommendations Flow

For Weather oriented outfit recommendations, as shown in Fig. 3.2, a huge dataset of outfit images is used for the recommendation purpose. Using Transfer Learning the ResNet based CNN model is trained and seasonal recommendations are made accordingly. Also the user can get a mixture of outfit recommendations for two different seasons together.

3.3 Virtual Try On

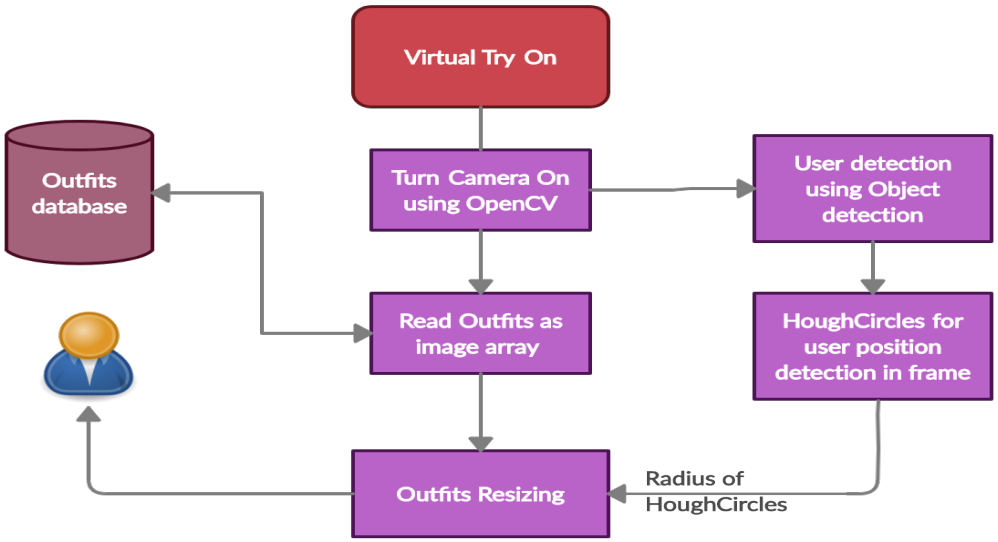

Figure 3.3: Virtual Try On Functional Design

The proposed Virtual Trial module is aimed at providing a personalized experience to users by letting them try out the recommended clothes. The users are able to actually visualize how they look in those outfits in a real time environment. As shown in Fig. 3.3, a database of the recommended outfits is created so that the user can choose which outfits to try on his/her body. Then the resizing of the outfits is done by determining the user's position in the live video stream. Accordingly, the width and height of the outfits are resized.

3.4 Similar Outfits Recommendations

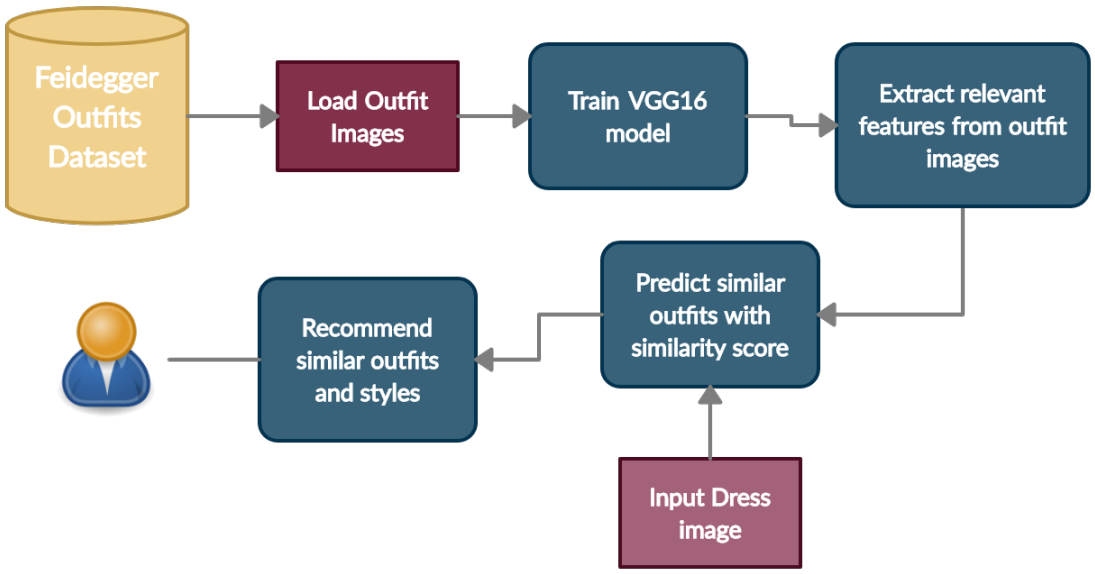

Figure 3.4: Similar Outfits Recommendations Working

The above Figure 3.4 describes the working of the Similar Outfit recommendations module. We have used a pre - trained VGG16 model for achieving high accuracy values. We used feature extraction methods to extract the relevant features from the Description of the images as given in the dataset. Then after computing the similarity indexes of outfit images with the respective input outfit image, we have given similar recommendations to the user for the outfit of his choice. These recommendations are different in colors and designs but similar in outfit patterns and styles.

Chapter 4

Implementation

Pocket Fashionista is an outfit recommendation system with various modules like - Skin Tone Detection and Classification module and outfit color recommendations, Similar Outfits recommendations, Weather based recommendations and Virtual trial Room.

4.1 Skin tone based Outfit Color Recommendations

The user is prompted to upload his/her picture. The system then classifies the person's skin tone from the Indian skin tones meter using OpenCV over a range of around 5 different tones namely - Fair, Wheatish, Medium Brown, Brown and Dark. Fig. 2 describes the overall workflow of this module.

The three color spaces for segmenting skin from the user's image are RGB (Red, Green, Blue), HSV (Hue, Saturation, Value) and YCbCr (Luminance, Chrominance) color models. Then skin segmentation from the user's image takes place. The BGR components are extracted from the image. The skin colour illumination's rule at uniform daylight is defined by the following equation on the user's image -

$R\_Frame > 95, G\_Frame > 40, B\_Frame > 20,$
$BRG\_Max - BRG\_Min > 15, abs(R\_Frame - G\_Frame) > 15,$
$R\_Frame > G\_Frame, R\_Frame > B\_Frame$

4.1.1 RGB color space

RGB values fall in a range of 0 to 255. For eg., RGB(0, 0, 255) is given as Blue color, as the last parameter ie. Blue is set to the highest possible value 255 and the other two parameters are set to the lowest value 0.

4.1.2 HSV color space

The position of the particular color in color space is set by Hue from 0 to 360 degrees. Value is a percentage value for luminosity and also Saturation is a percentage value both considered from 0% to 100%.

4.1.3 YCbCR color space

The YCbCr transformation from RGB (red, green, and blue) image source is as given below :

Y = 0.299×R + 0.587×G + 0.114×B
Cb = — 0.1687×R — 0.3313×G + 0.5×B + 128
Cr = 0.5×R — 0.4187×G — 0.0813×B + 128

The Y component shows the picture in the same way as it is, only in black white (low brightness & high brightness) mode. To calculate the Y component, the source image is converted to grayscale. Cb and Cr images contain the Blue and Red components of the source image respectively.

4.1.4 Skin Thresholding Algorithm

In this algorithm we separate the skin part from the non-skin area using a linear separation method. This technique proposes fixed skin limits in a particular given color shading space.

RGB (Rule A) -

For this, initially the RGB bounding rule algorithm is implemented where we also manage the light illumination effects under which the user has taken the picture.

In this way, we classify the skin part by heuristic standards in which two unique conditions are taken into consideration like uniform light conditions and flash light or lateral enlightenment.

Uniform daylight illumination:(Rule1)
$R > 95, G > 40, B > 20,$
$(Max\{R, G, B\} - min\{R, G, B\}) > 15,$
$|R - G| > 15, R > G, R > B$

Flashlight or daylight lateral illumination:(Rule2)
$R > 220, G > 210, B > 170,$
$|R - G| \leq 15, B < R, B < G.$

We have combined both the rules by ORing them. So the final rule that is generated is as follows :
$RGB\_Rule = (Rule\_1)U(Rule\_2)$

The output is a RGB mask.

YCbCr (Rule B) -

We have utilized a skin color map on the chrominance segments of the source image to distinguish the skin pixels. Many procedures of regularization are used during the calculation at that point of time to separate the areas of skin color pixels bound to have a place with the facial locales. We use the color division step here. It was found that spaces of Cb and Cr color ranges tend to delegate for the skin color reference map in the YCbCr color space as given below :

Cr $\leq 1.5862Cb + 20$
Cr $\geq 0.3448Cb + 76.2069$
Cr $\geq -4.5652Cb + 234.5652$
Cr $\leq -1.15Cb + 301.75$

$\text{Cr} \leq -2.2857Cb + 432.85$

After applying this mask, the YCbCr mask picture of the original image is produced. Fig. 3 shows the Bounding rule for Cb-Cr color space.

HSV (Rule C) -

The Hue values perform the segregation of the skin from the non-skin areas in the HSV color space significantly. We have estimated the hue value as:

$H < 50$

$H > 150$

Thus the Hue mask is generated.

RGB-YCbCr-HSV

Now we combine all the RGB, HSV and YCbCr masks to generate an algorithm which generates the RGB-YCbCr-HSV mask, which when applied on an input image generates the extracted skin from it.

Hence in order to get a good output accuracy, we need to slightly change the coefficients of some of the above mentioned equations. Now we classify the extracted skin into 5 different Indian skin tones namely - Fair, Wheatish, Medium Brown, Brown, Dark. This classification is based on the threshold values of the skin extracted from the image which gave a good accuracy.

The ranges for a skin pixel used in this proposed algorithm are as follows:

$0 <= H <= 17 and$

$15 <= S <= 170 and$

$0 <= V <= 255$

and

$0 <= Y <= 255 and$

$135 <= Cr <= 180 and$

$85 <= Cb <= 135$

To find the dominant colors, we used the K-Means Clustering Algorithm. K is used to cluster the pixel data based on their threshold values. Further the user's skin tone will be classified by particular threshold values into Fair, Wheatish, Medium Brown, Brown and Dark.

Complexion based recommendations

Skin tone classification model explained above passes the user's appropriate skin-tone to this module. Based on that we defined specific outfit colors to particular skin tones. We used the "men-formal-shirts.csv" dataset for recommending the suitable colors to the user. In the dataset we considered attributes like "Description Color" to extract the color name of the clothes. Accordingly outfits will be shown to the user by getting images of the clothes of those colors from the dataset and using the matplotlib library, the images will be plotted for recommendations.

4.2 Weather oriented Outfit Recommendations

Seasonal recommendations have been built on Convolutional Neural Networks, with transfer learning from ResNet and approximate nearest neighbors.

Convert images to embeddings

We have used the DeepFashion data set with v1 of the data, with 24K+ images. We have around 46 categories of outfits in this dataset. The seasons considered are - Winter, Summer, Spring, Autumn. Then we convert images to categorical embeddings.

Conduct Transfer Learning from ResNet

We used the Resnet 18/50 layers for training the CNN model. There are many layers for Resnet, like resnet18, resnet34, resnet50, resnet101, resnet152; where the numbers are the number of layers. The more the layers the model is more accurate but takes longer to train. We aimed to get top 1 and top 5 accuracies. Hence we found resnet18 to be a simple model that can be trained on free tier. Then we saved the model to import it conveniently later. We then just evaluated the model for the prediction of the categories of the clothes wherein we observed the predicted and actual outputs are the same giving a 100% accuracy score with 0% loss.

Use Fastai hooks to retrieve image embeddings

Now we retrieve the image embeddings and load the saved model for further process. It takes time to populate the embeddings for each image. We get 2nd last layer of the model that stores the embedding for the image representations. The last linear layer is the output layer. We prepare the data for generating recommendations excluding the test data. We get the embeddings from the trained model.

Use Approximate Nearest Neighbors and embeddings centroid detection to obtain most similar images based on the embeddings

We finally used Approximate Nearest Neighbors algorithm for generating the similar clothing recommendations. We also computed images similar to the centroid. We then pass a set of season-wise images to the model for generating similar recommendations. We selected 24 outfits for each season. They will act as the seed images for Seasonal Collections. We only pass images into the model; the model does not ingest additional attributes/descriptions/product details; this is because we want the model to automatically learn and detect the style of fashion images passed into it without further human/machine labeling.

Centroid embeddings will then merge all the seed images into one representation by averaging the values across all dimensions. Finally, Approximate nearest neighbors is applied to return outfits closest to the representation. Thus the group of similar images as per the season passed are recommended to the user.

4.3 Virtual Try On

We have used the OpenCV library of Python for capturing the live video stream. Then all clothes to be tried on are read. From the images that the user can try on, we are resizing them to fit on the user's body. The person in the video stream is detected using Object detection. Then the HoughCircles formula is used for estimating the size of the clothes for further resizing.

We have used HoughCircles() to determine the area in which the user is standing in front of the frame. According to the obtained measurements of the radius, we then use the resize() function of the imutils library to resize the clothes. Resizing takes place by increase/decrease of either the height/width of the clothes. The user can move back or forward to check out different clothes. If the user wants to save a screenshot then he/she can also do so.

4.4 Similar Outfits Recommendations

This is a Content based recommendation system wherein we use Transfer learning. We have used the Feidegger dataset - composed of dress images and related textual descriptions of 8732 high-resolution images. The pretrained VGG16 model is used here to extract the relevant features from our dress images and build a similarity score on them. We 'cut' the VGG at the second-last layer, so we obtain for every single image a vector of dimension 1x4096. We have trained the model for 500 outfits. The train test split is of 80-20%. The training data is used for building a similarity score matrix.

Then we make the prediction on data by using the CNN models. Then we stored the model in a pickle format. We then compute the similarity matrix for the other clothes in the dataset. We've chosen the cosine similarity as the similarity score. Whenever we pass a dress image to our system, we compute the similarity with all our dresses stored in 'train' and then we select the most similar (with the highest similarity scores). Finally we plot the most similar outfits ranked by their similarity score as per the user's input of clothes as per his choice.

Chapter 5

Results and Discussion

5.1 Skin tone based Outfit Color Recommendations

5.1.1 Skin Segmentation

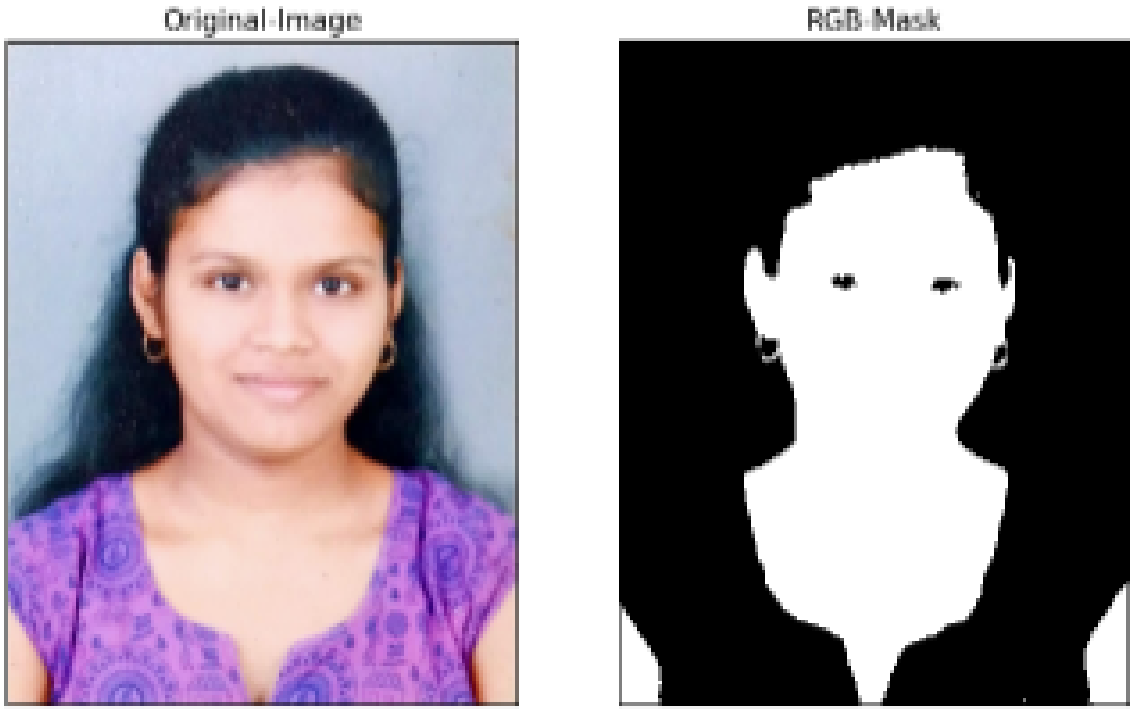

Figure 5.1: RGB Mask

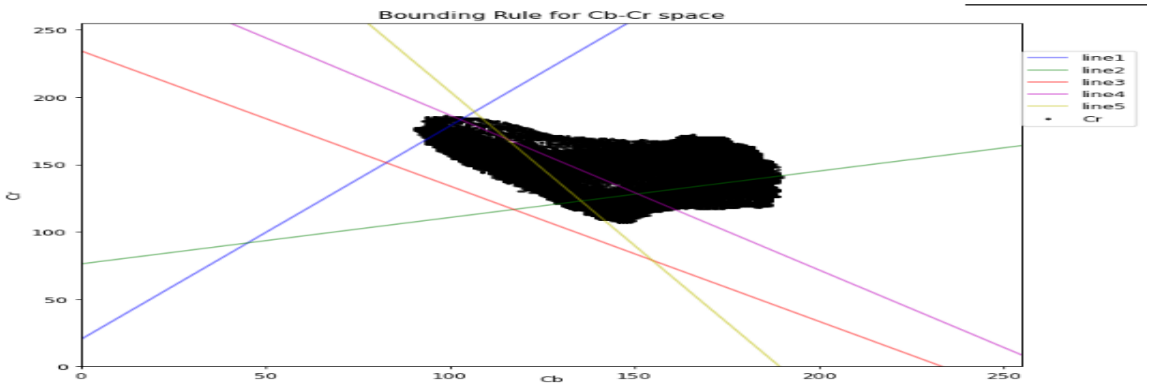

Figure 5.2: Bounding rule for Cb-Cr Space

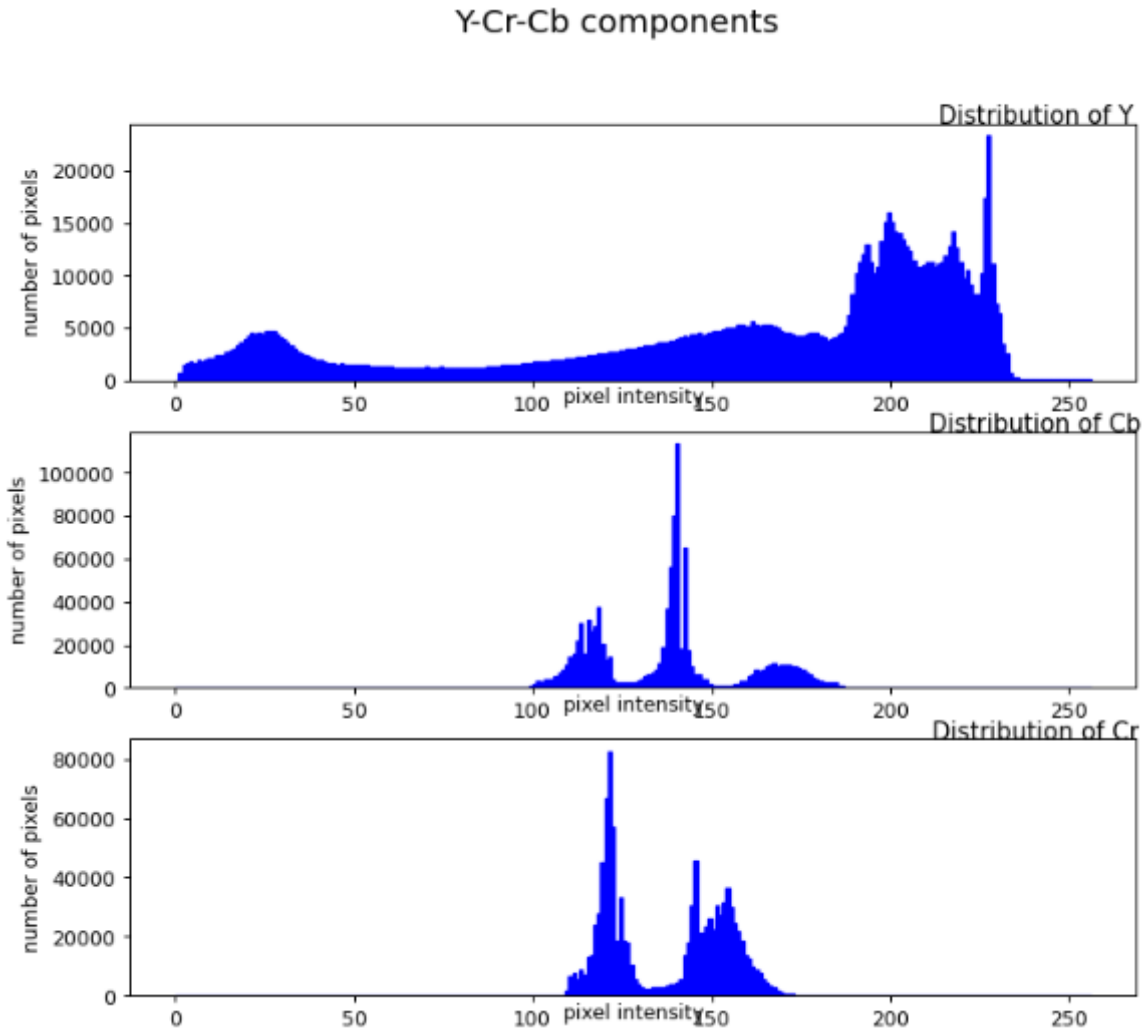

Figure 5.3: Y-Cr-Cb components

Figure 5.4: YCbCr Mask

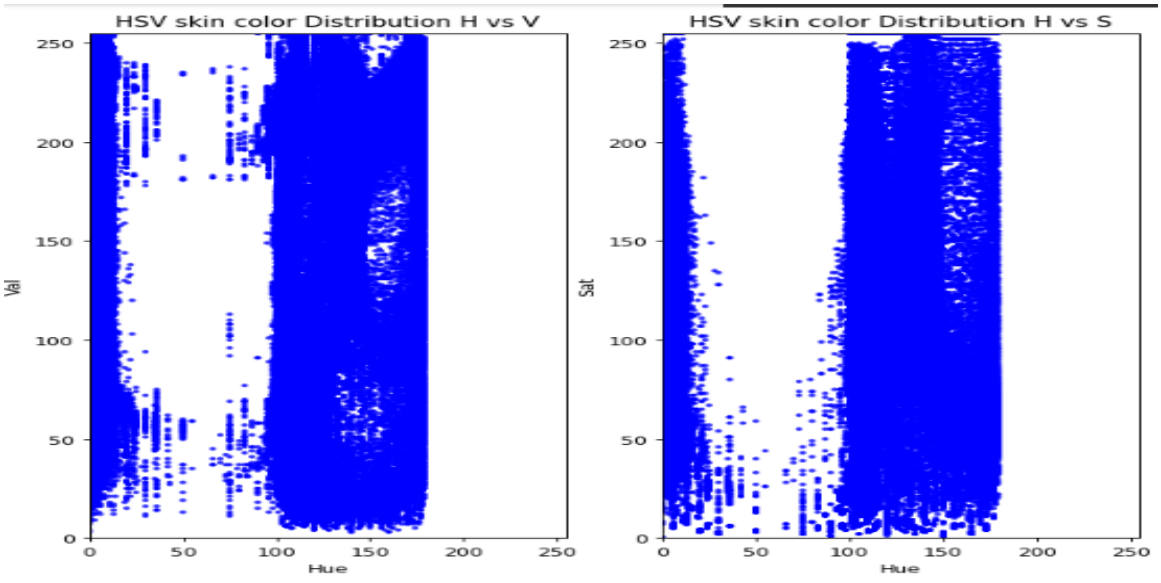

Figure 5.5: HSV Skin color distribution

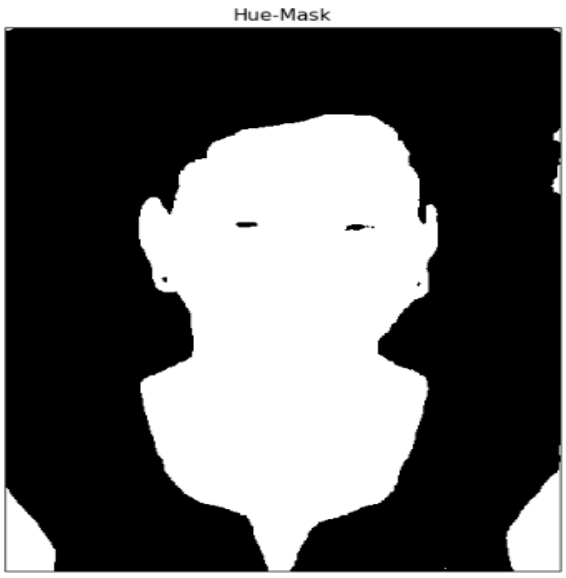

Figure 5.6: HSV Mask

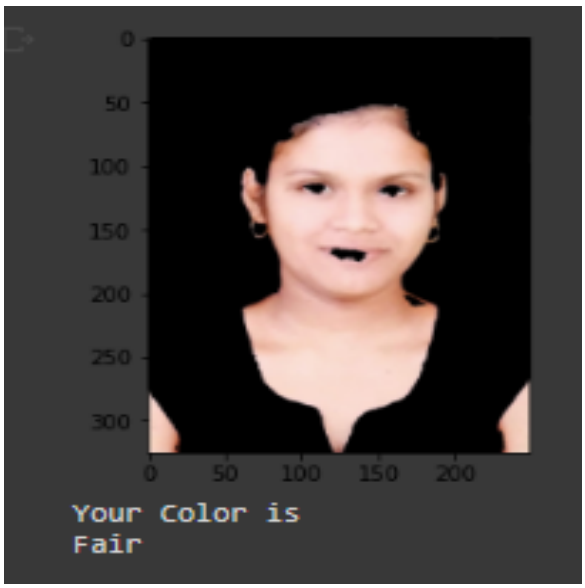

Figure 5.7: Fair Skin tone

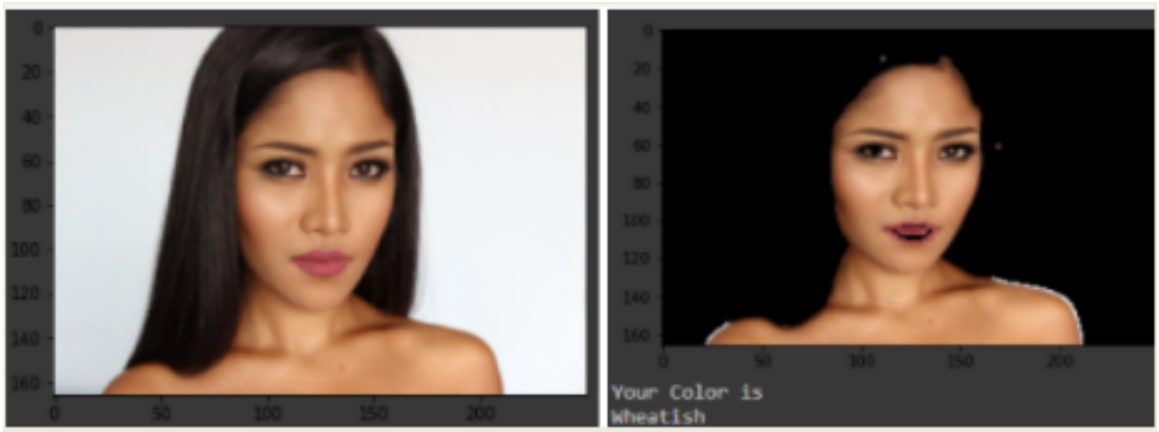

Figure 5.8: Wheatish Skin tone

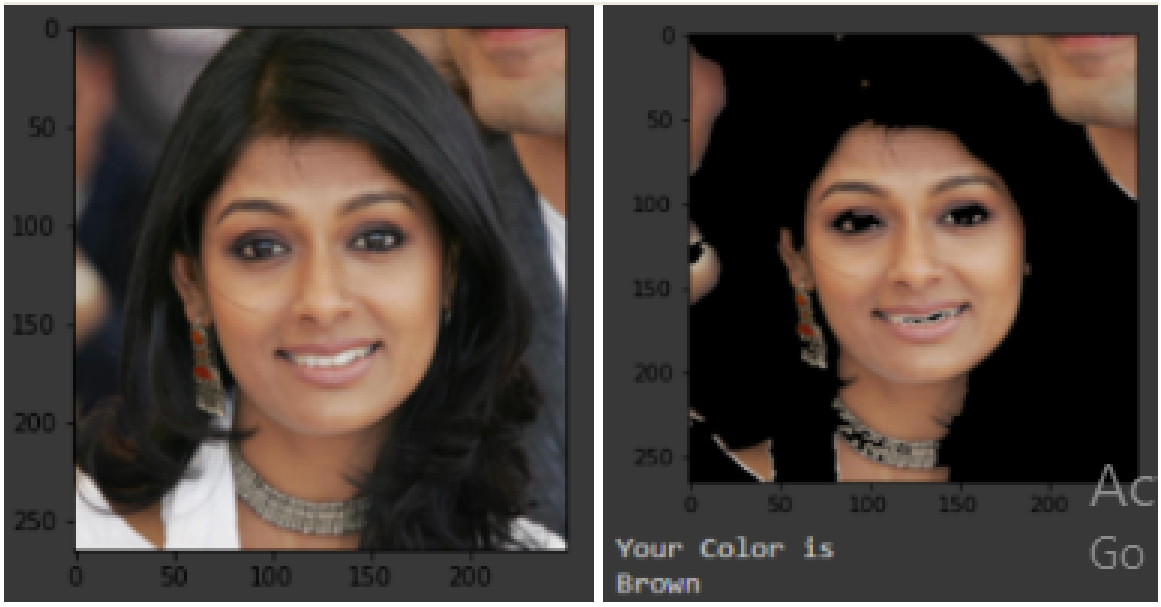

Figure 5.9: Brown Skin tone

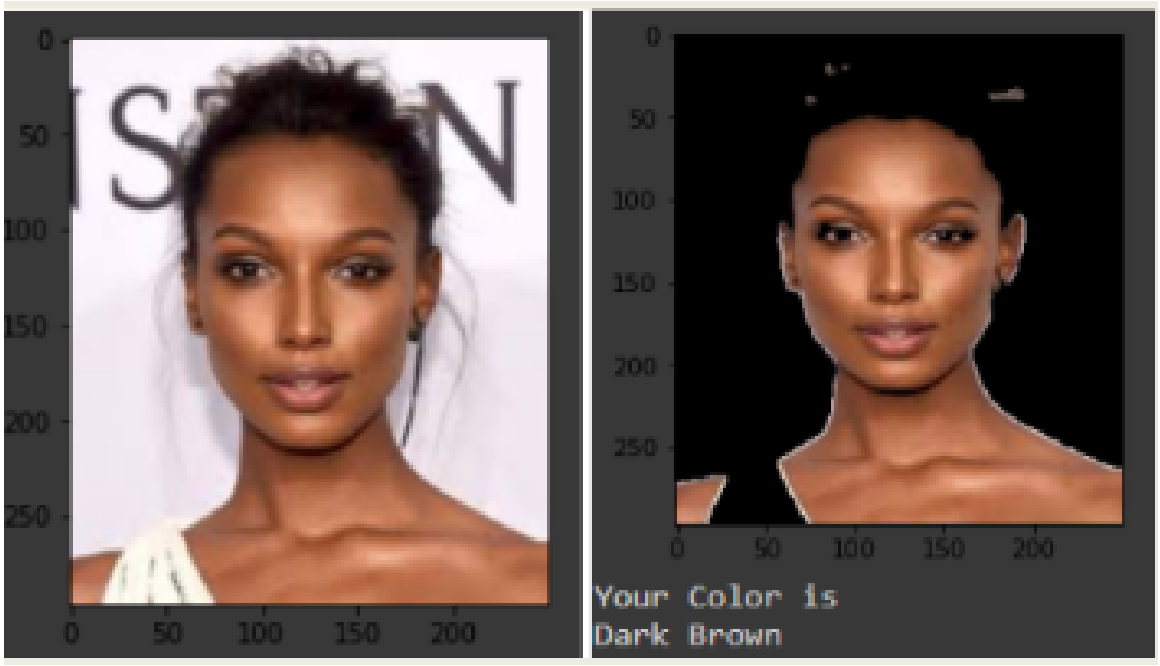

Figure 5.10: Dark Skin tone

5.1.2 Complexion based recommendations

Figure 5.11: Outfit color recommendations for Fair Skin tone

Figure 5.12: Outfit color recommendations for Brownish Skin tone

5.2 Weather oriented Outfit Recommendations

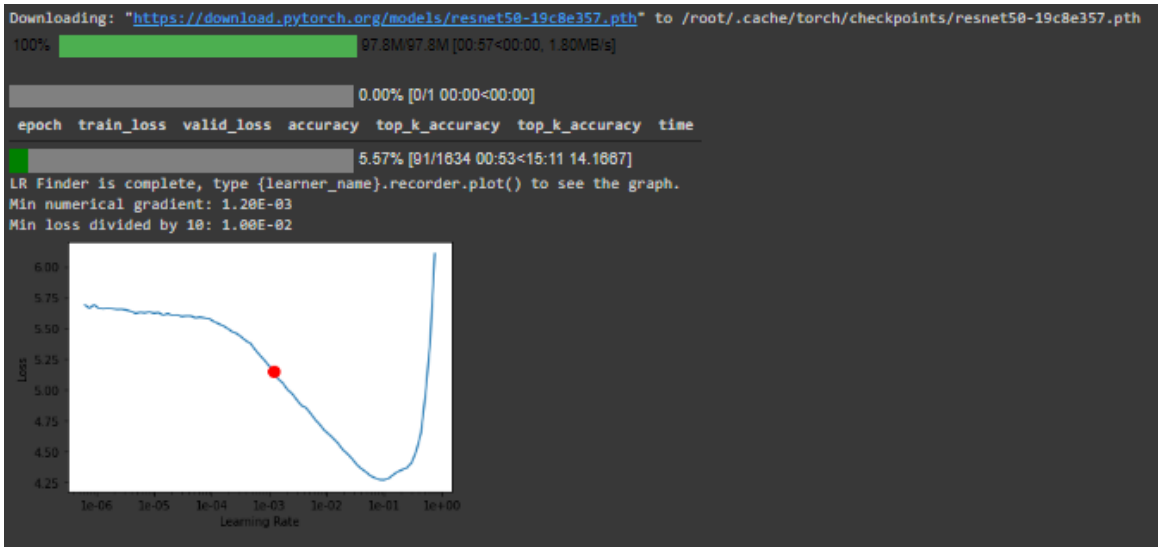

Figure 5.13: CNN Resnet 18 training

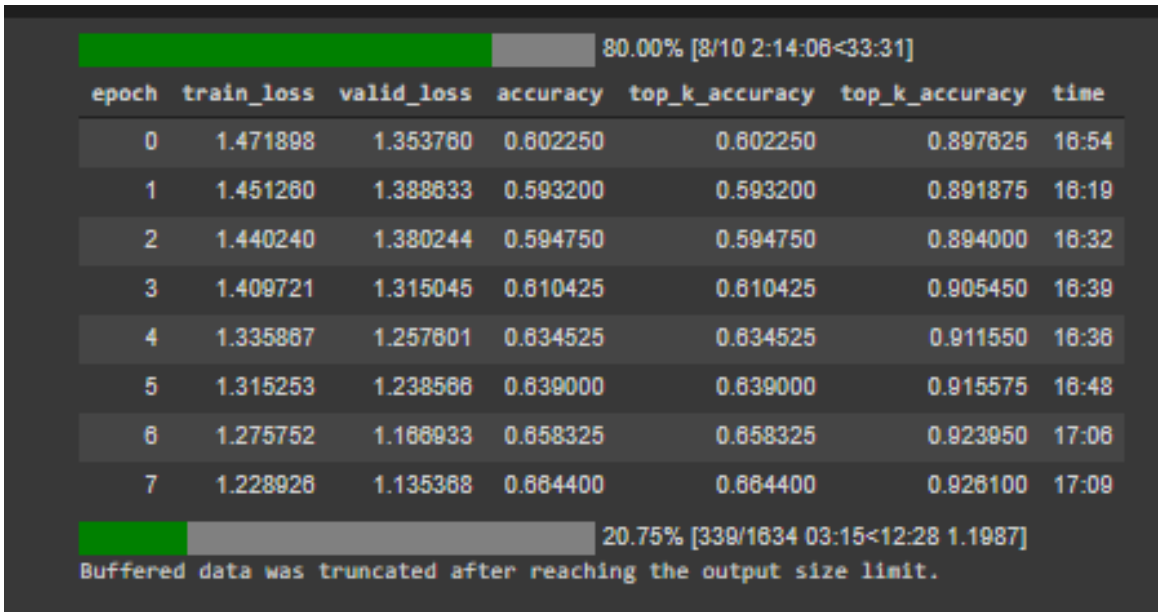

Figure 5.14: ResNet model accuracies

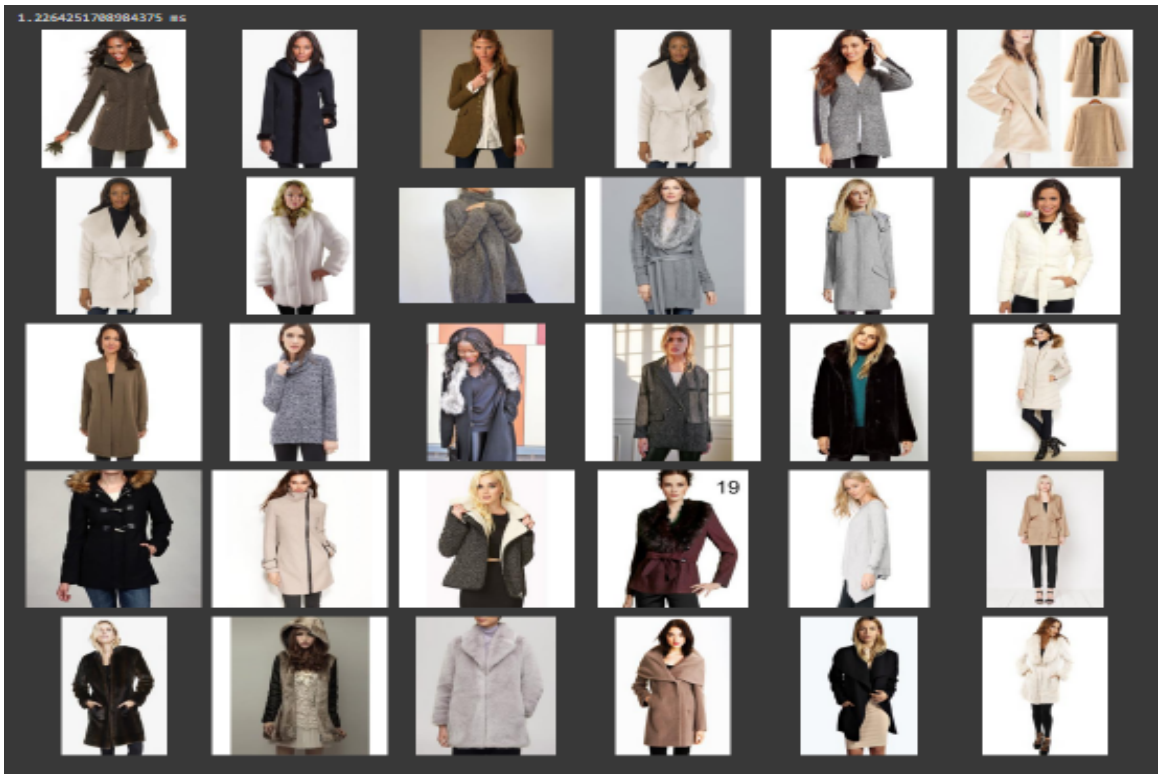

Figure 5.15: Winter-Spring Outfits recommendations

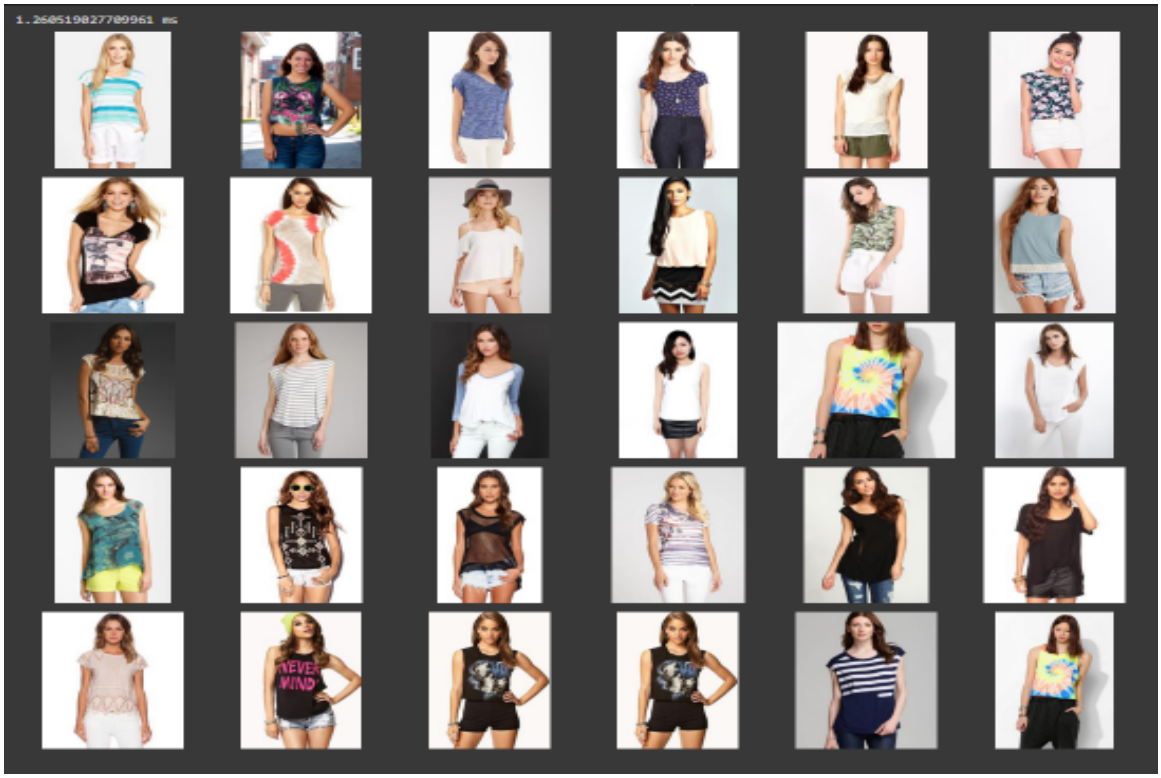

Figure 5.16: Summer-Autumn Outfits recommendations

5.3 Virtual Try On

Figure 5.17: Virtual Try On - outfit1

Figure 5.18: Virtual Try On - outfit2

Figure 5.19: Virtual Try On - outfit3

5.4 Similar Outfits Recommendations

```
Downloading data from https://storage.googleapis.com/tensorflow/keras-applications/vgg16/vgg16_weights_tf_dim_ordering_tf_kernels.h5
553467904/553467096 [==============================] - 9s 0us/step
Model: "functional_1"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
input_1 (InputLayer)         [(None, 224, 224, 3)]     0
_________________________________________________________________
block1_conv1 (Conv2D)        (None, 224, 224, 64)      1792
_________________________________________________________________
block1_conv2 (Conv2D)        (None, 224, 224, 64)      36928
_________________________________________________________________
block1_pool (MaxPooling2D)   (None, 112, 112, 64)      0
_________________________________________________________________
block2_conv1 (Conv2D)        (None, 112, 112, 128)     73856
_________________________________________________________________
block2_conv2 (Conv2D)        (None, 112, 112, 128)     147584
_________________________________________________________________
block2_pool (MaxPooling2D)   (None, 56, 56, 128)       0
_________________________________________________________________
block3_conv1 (Conv2D)        (None, 56, 56, 256)       295168
_________________________________________________________________
block3_conv2 (Conv2D)        (None, 56, 56, 256)       590080
_________________________________________________________________
block3_conv3 (Conv2D)        (None, 56, 56, 256)       590080
_________________________________________________________________
block3_pool (MaxPooling2D)   (None, 28, 28, 256)       0
_________________________________________________________________
block4_conv1 (Conv2D)        (None, 28, 28, 512)       1180160
_________________________________________________________________
block4_conv2 (Conv2D)        (None, 28, 28, 512)       2359808
_________________________________________________________________
block4_conv3 (Conv2D)        (None, 28, 28, 512)       2359808
_________________________________________________________________
block4_pool (MaxPooling2D)   (None, 14, 14, 512)       0
_________________________________________________________________
block5_conv1 (Conv2D)        (None, 14, 14, 512)       2359808
_________________________________________________________________
block5_conv2 (Conv2D)        (None, 14, 14, 512)       2359808
_________________________________________________________________
block5_conv3 (Conv2D)        (None, 14, 14, 512)       2359808
_________________________________________________________________
block5_pool (MaxPooling2D)   (None, 7, 7, 512)         0
_________________________________________________________________
flatten (Flatten)            (None, 25088)             0
_________________________________________________________________
fc1 (Dense)                  (None, 4096)              102764544
_________________________________________________________________
fc2 (Dense)                  (None, 4096)              16781312
=================================================================
Total params: 134,260,544
Trainable params: 134,260,544
Non-trainable params: 0
_________________________________________________________________
```

Figure 5.20: VGG16 model

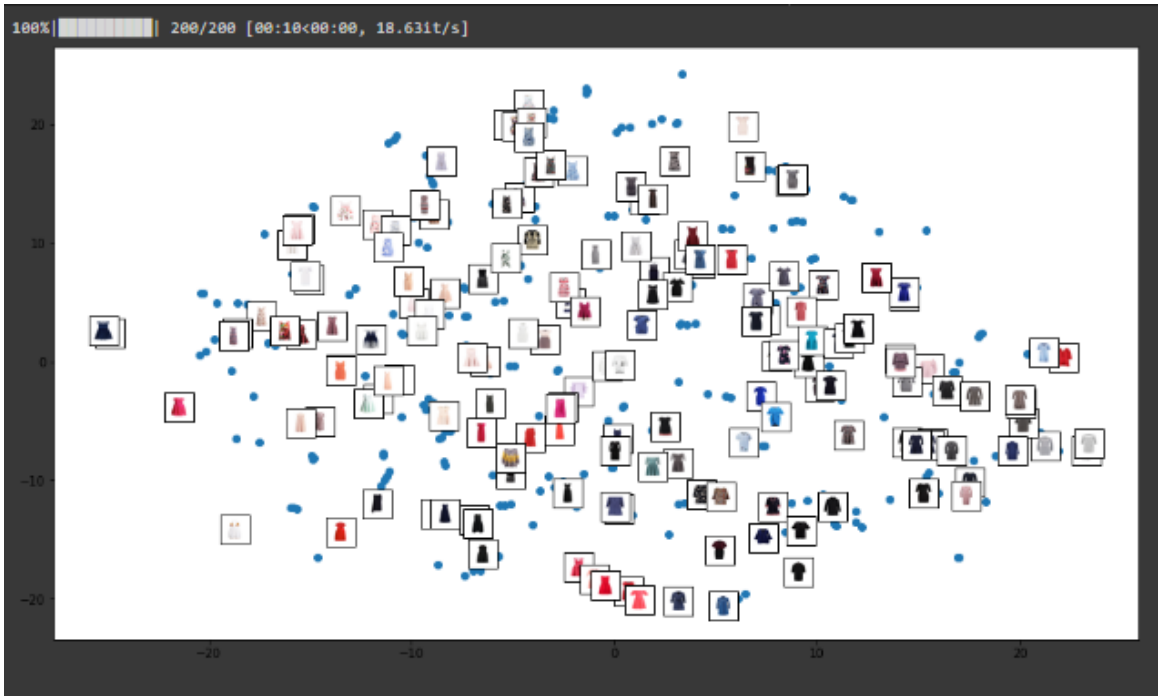

Figure 5.21: Features plot in a 2D space

Figure 5.22: Similar Outfits Recommendation-1

Figure 5.23: Similar Outfits Recommendation-2

Chapter 6

Conclusions

The proposed system recommends outfits and their color combinations to users based on the skin tone of the user. The system also considers weather conditions for best suited outfits recommendations. A virtual trial room is also provided for the user to try on the recommended outfits.

The perplexity of choosing various suitable colours of outfits is minimised by the featured modules. The proposed system recommends outfits and their color combination to users based on the skin tone of the user. By isolating the pixels of skin color, the predicted output is analysed and processed for further recommendations. Categorically, the outfits are placed which gives a personal touch to the recommendations and users will be able to find suitable combinations just by uploading their picture.

Weather based recommendations are introduced to keep up with fashion regardless of any particular area, its geographical location and the climate conditions in those areas. A virtual trial room is also provided for the user to try on the recommended outfits. The feature allows the user to figure out the outfit suitability, its match with the skin complexion and the user will be able to experience the dynamic output presented by this module. Along with the recommended outfit, the users will also be able to try different clothes of similar type which will be recommended by the system. The module will help to minimize the time required for choosing an outfit and thus will result in efficient shopping and outfit selection process.

Thus this system is a full proof “Fashion Advisor” for people who are worried about what to wear and lack fashion sense.This will serve as a real-time system that satisfies customer demands.

Chapter 7

Future Scope

Along with the outfit colour recommendations based on skin type and categorical color recommendations based on weather, the system can also be made able to recommend accessories based on the selected outfits like watches for men, earrings for women, shoes, bags or purse for women. The concept and technology can be adapted by established online platforms where they can integrate this system to improve their customer engagement with the website and also provide optimum solutions to the customers.

Further we can implement one more module that is, event based and occasion based recommendations. There are various events lined up for us to dress for, and the system can be able to recommend outfits based on events such as weddings, parties, funerals, etc. Users can also pre-plan his/her outfit according to the upcoming event, as per the calendar application event setting functionality.

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