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SCHOOL OF COMPUTER SCIENCE & ENGINEERING

FINAL REPORT

CSE3013 - ARTIFICIAL INTELLIGENCE

Outfit Recommendation System using AI

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Under the guidance of

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1. Abstract (Project Overview):

Fashion is becoming a much more popular subject among the general public which has led to fashion industries moving online. This project works towards making one's fashion experience more opportune and comfortable. It offers various specifications that make looking for clothes or building an outfit and giving those specifications to a tailor in a much simpler process.
Some practical problems that this project will encounter include:
- Enabling a feature to try on clothes using image processing.
- How to find a similar item of clothing by searching.
- Explaining our requirements in the outfit to the tailor clearly.
- Taking measurements on our own to get the outfit stitched by the tailor.

A potential business model will be proposed in order to reach out to the tailors.

This project works towards making shopping a much easier and hassle-free experience for the users considering that the fashion industry is expanding.

2. Introduction

AI aims at making our day-to-day activities a little more effective and a lot easier. The idea behind this project is to take one of the most essential aspects of our everyday life and integrate it with AI. AI in the Fashion industry is prevailing tremendously and this project explores that aspect even further. In this project, we proposed a personalized Tailoring mechanism system in which the user can select the requirements from the filters provided, find a similar outfit with an image input, generate measurements of him/her and connect with a tailor to get this expected outfit ready. Unlike the conventional systems where we usually take out time to meet the tailor in person, explain our requirements and give measurements: this project aims at making this process much simpler and easier to deliver our idea and connect with a tailor without the burden of meeting them in person.

3. Background / Related Work

[1] A Comparative Study of Outfit Recommendation Methods with a Focus on Attention-based Fusion | Request PDF

→ This research looks at how to incorporate relevant product attributes gathered from visual and textual data in semantic, multimodal item representations to provide outfit recommendations.

[2] Explainable Outfit Recommendation with Joint Outfit Matching and Comment Generation | IEEE Journals & Magazine | IEEE Xplore

→ The neural outfit recommendation (NOR) framework proposed in this study is a unique neural network architecture that delivers outfit suggestions while also generating abstractive remarks. The two aspects of neural outfit recommendation (NOR) are outfit matching and comment generating.

[3] Image-based Recommendations on Styles and Substitutes

→ This article suggests a system capable of proposing clothing and accessories that will go well together (and which will not), as well as a variety of additional uses.

[4] OutfitNet: Fashion Outfit Recommendation with Attention-Based Multiple Instance Learning

→ This research provides a fashion outfit recommendation framework (OutFitNet) that uses visual information to learn the compatibility between fashion items, creates relevance embedding of fashion products, and learns the users' preferences for fashion outfits. It learns the compatibility among fashion items, the users' likes toward each item, and the users' focus on different things in the outfit using the attention mechanism by taking in many fashion items in a fashion outfit as input.

[5] Recommendation System for Outfit Selection (RSOS)

→ This study proposes a system that would be able to suggest acceptable clothing for the user based on their personality. This method is required in order to decrease the time spent selecting and purchasing garments; it will also aid in the creation of tailor-made ensembles based on personality factors.

[6] FITME: BODY MEASUREMENT ESTIMATIONS USING MACHINE LEARNING METHOD

→ This paper proposes a model that estimates human measurements from real time human pictures using haar cascade classifier and support vector machines.The suggested method then uses computer vision and machine learning approaches to extract information from photographs in order to estimate body measurements (e.g., waist and bust). The approach then employs a support vector machine (SVM) to estimate the ideal shopper size. Using such a method will assist online shoppers in precisely estimating their body measurements, hence improving the whole online purchasing experience.

[7] (PDF) An Approach for Clothing Recommendation Based on Multiple Image Attributes

→ In this research, we present a novel approach for analyzing image content in distinct aspects for clothing selection that extracts multi-features from photos. To distinguish split joint clothing, a color matrix model is suggested. To represent fabric pattern attribute, the ULBP feature is retrieved. To define collar and sleeve properties, PHOG, Fourier, and GIST features are derived. Then, the classifiers are trained to distinguish between different types of clothing fabric and split joint types.

[8] Automatic Suggestion of Outfits using Image Processing

→ This programme will suggest the best option based on specific aspects that will suit the user's characteristics. Unlike the current system, this one will tailor clothing to the user's attributes, giving them confidence. Choosing the proper attire for the right occasion may be time consuming and tedious. Indecisive and negligent people face the problem of looking less confident and not keeping up with trends. This research focuses on using image processing to detect and recognise faces and facial traits. It also entails the analysis of the dataset in order for the user to obtain the best-suited outfit for the specified qualities.

[9] (PDF) Fashion Recommendation Systems, Models and Methods: A Review

→ This study aims at helping researchers, academics, and practitioners interested in machine learning, computer vision, and fashion commerce in gaining a better understanding of the various fashion recommendation systems. This review also looks at many potential models for developing fashion suggestion systems in the future.

[10] (PDF) A mobilized automatic human body measure system using neural network

→ Mobilized autonomous human body measurement systems to have a high degree of mobility, are simple to operate and have a good level of accuracy. Existing systems, on the other hand, prioritize accuracy and resilience over mobility and comfort. To address this limitation, this paper develops a mobile autonomous human body measuring system (MaHuMS-NN) that uses supervised learning to improve general measurement outcomes,

[11] Weather-to-garment: Weather-oriented clothing recommendation

→ This research proposes a workable technique for automatically generating weather-related wardrobe recommendations. Given the weather data, the system may intelligently advise the most appropriate clothes from the user's personal clothing album, or automatically recommend the most appropriate clothing from the user's personal clothing album. They demonstrate that their trained model is successful for both weather-oriented apparel suggestion and matching using the Weather-to-Garment (WoG) dataset

[12] Outfit Recommendation System Based on Deep Learning Ying Huang a, Tao Huang
→ This research paper offers a deep learning-based outfit suggestion system. There idea was to use the system not just to determine whether or not an outfit is good, but also to recommend good outfits to users when they are provided with a pool of fabric items to choose from. There proposed model consists of two parts: a feature extractor based on ResNet-50 and a binary classifier that classifies clothing into good and bad categories.

4. Real-life Applicability

Fashion has become an integral part of modern life; it shapes tastes, defines individuals and groups, mediates communication, and satisfies disparate wants and aspirations. Fashion has claimed its place in today's market and upholds prevalent research in various patterns and trends.

Millions of people around the globe are glued to their devices in order to stay up to date with the latest fashion and, there are already many existing ways to categorize clothing and help users pick ideas of their choice and interests. Along with this, we find it quite difficult to explain our requirements in outfits to a tailor. Our aim is to provide an AI-based approach that makes this process much easier and more convenient. It can aid fashion lovers in finding the perfect outfit according to various parameters, generate their measurements using the tailoring mechanism and connect to a tailor to get their outfit stitched. Moreover, it helps in making shopping online a trustworthy and convenient

experience as a lot of users are hesitant about the fitting of clothes. The tailoring mechanism will benefit the tailors who aren't recognised as well, this will provide a platform for the tailors to exhibit their expertise without having to manually take measurements.

This project connects two end users , customers and tailors. It provides a whole lot of diverse features , that when they come together, create a helpful environment. The customer can take measurements and send it to the tailor without physical effort. The customer can virtually try on outfits and search for similar looking outfits as well.

5. Individual Contribution:

Swithika

Tailoring Mechanism, UI and Business Model

Sriya

Tailoring Mechanism, UI and Business Model

Nikhitha

Try-On (Image processing) , Image searching and Documentation

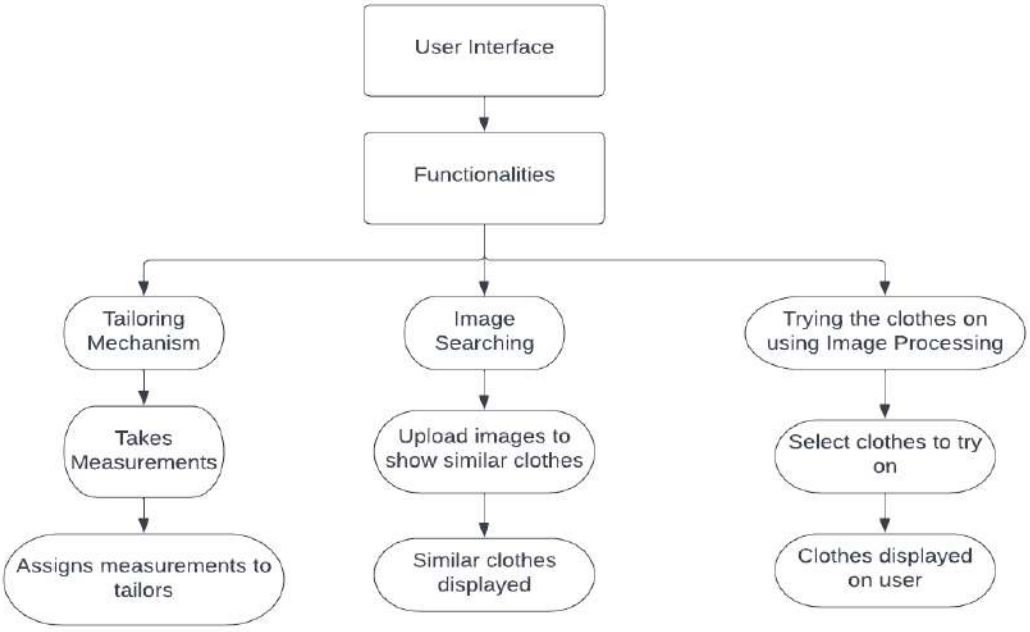
Bhumika

Try-On (image processing) , Image searching and Documentation

6. Tools and Technologies used / Hardware – Software Requirements

- pandas
- NumPy
- OpenCV
- Scikit-learn
- OpenCV-python
- CV2
- Tensor-flow

7. Proposed System Process Flow



8. Working Methodology

A) Tailoring Mechanism

This mechanism aims to determine the body measurements of a person accurately from a set of images. In order to carry this out, we must need at least one object in the image with a known metric. The object that we'll be using is a chessboard.

- **Algorithms Used:**
  - Corrections: Affine and Metric
  - Green Screen Segmentation
  - Detection of body parts

Green Screen is used for segmentation using the Chroma King method. This provides accurate results as it segments the image based on the provided colour. The iterations are fast as well.

For detecting the body parts:
For shoulder points

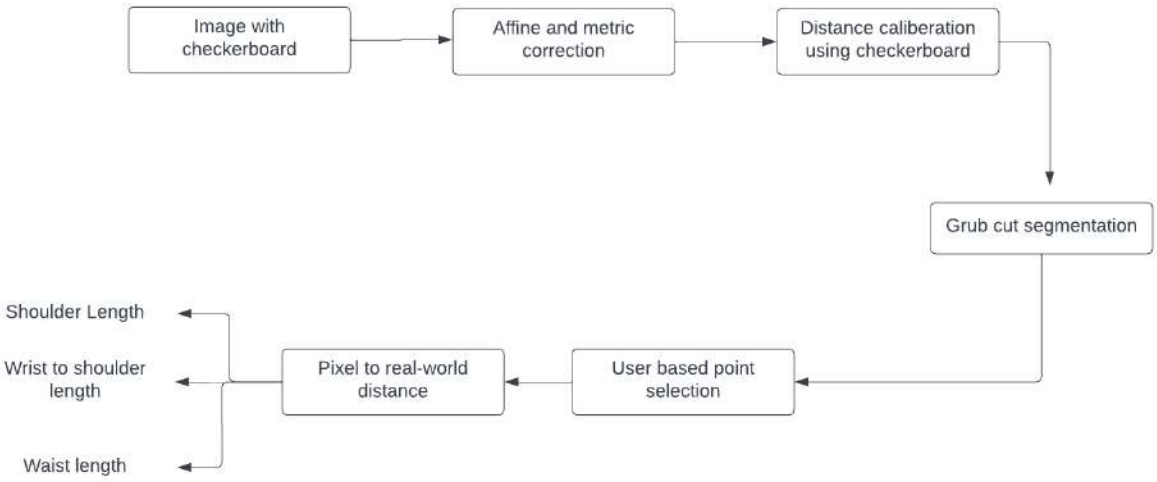
- We first find the tip of the head as the highest point in the silhouette

- We then move along the horizontal directions from the tip and stop at the point where there is a drastic change in the slope in a window, giving us the shoulder tips
- We further use a similar heuristic for the wrist points.

Approximating the waist from two images

- We approximate the waist of the human body as an ellipse
- We calculate the semi axis of the ellipse from two images where the person is facing the camera in one image and orthogonal in another

The flowchart for the process is shown below:



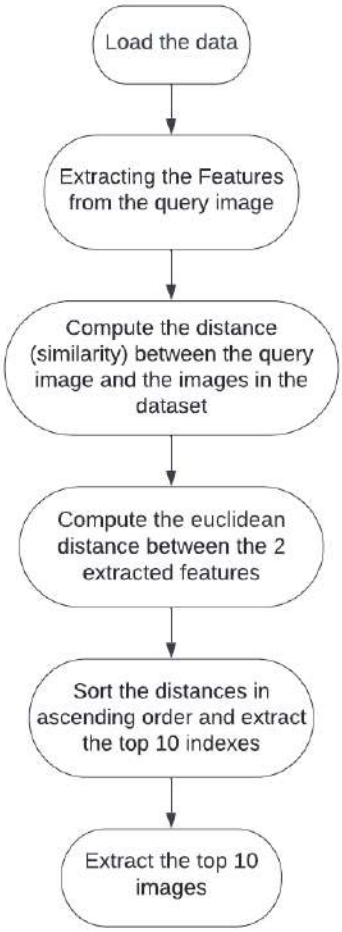
B) Image Searching

This functionality aims to return images of clothing items similar to the input image that has been uploaded. The engine is created using transfer learning techniques. Pre-Trained CNN architectures are used and evaluated.

- **Architectures Used:**
  - ResNet50
  - VGG 16
  - Xception

Euclidean distance has been used as the similarity metric. Deployment is being conducted using VGG 16.

Flow-diagram explaining the workflow of the section:



C) Trying on clothes using Image Processing:

Trying on clothes using Image processing consists of multiple tasks including detection of the user's face from video stream, alignment of models, approximating the position of torso and lower body based on face detection and resizing input dress images and dress up using Image Processing.

The Languages and technologies used in this section are

- HTML, python
- OpenCV
- Flask.

OpenCV is a large open-source library for computer vision, machine learning, and image processing, and it currently plays a critical part in real-time operations, which are critical in today's systems. It may be used to detect items, faces, and even human handwriting in photos and movies. Python can process the OpenCV array structure for analysis when it is combined with other modules such as NumPy. We employ vector space and execute mathematical operations on these features to identify visual patterns and their various features.

It is a very useful technique when we required scaling in object detection. OpenCV uses two common kinds of image pyramids Gaussian and Laplacian pyramid. Use the pyrUp() and pyrDown() function in OpenCV to downsample or upsample a image. Check the below code for practical implementation

Flask is a web application framework written in Python. It has multiple modules that make it easier for a web developer to write applications without having to worry about the details like protocol management, thread management, etc.

Flask application will first render the home.html file and whenever someone sends a request for the image classification, Flask will detect a post method and call the get_image_class function.

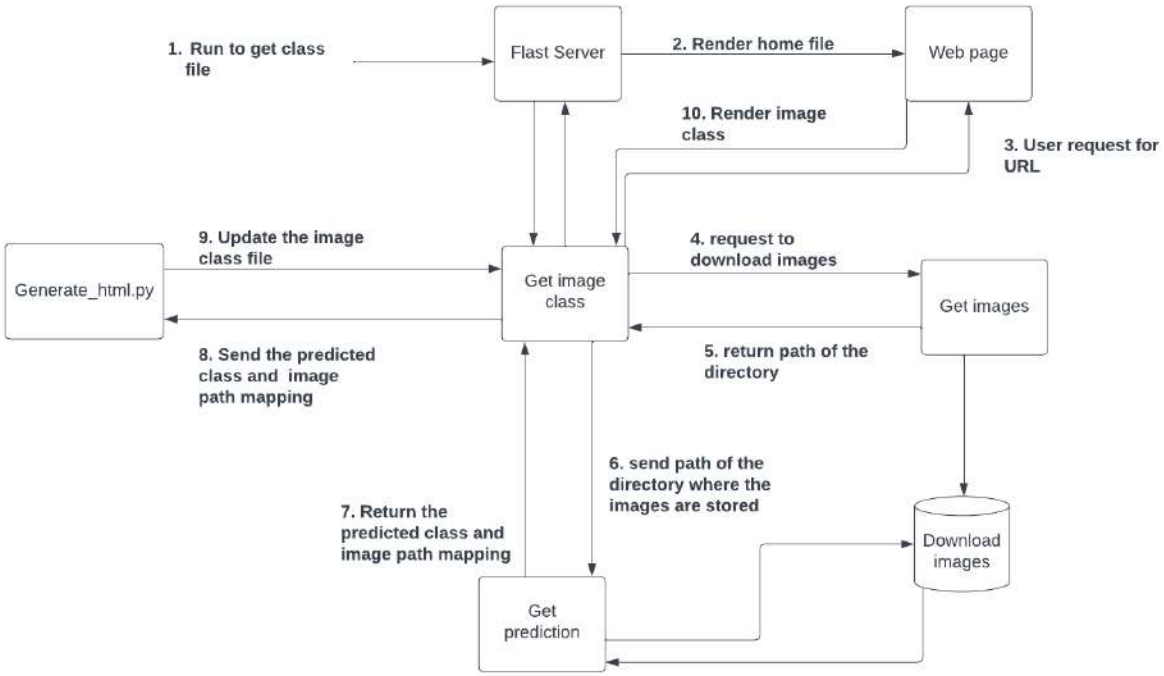
This function will work in the following steps:

First, it will send a request to download the images and store them.

Next, It will send the directory path to the get preditcion file which will calculate and return the results in the form of a dictionary.

Finally, It will send this dictionary to the generate html generating the output file which will be sent back to the user.

Flow-diagram explaining the workflow of the section:

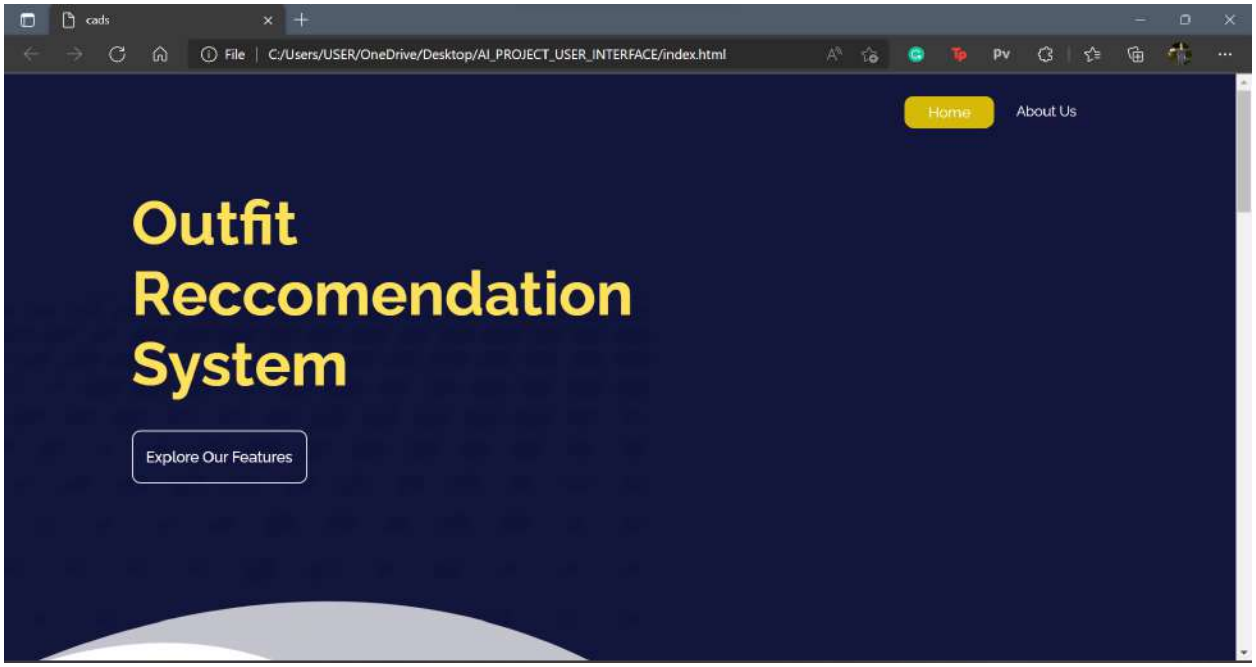


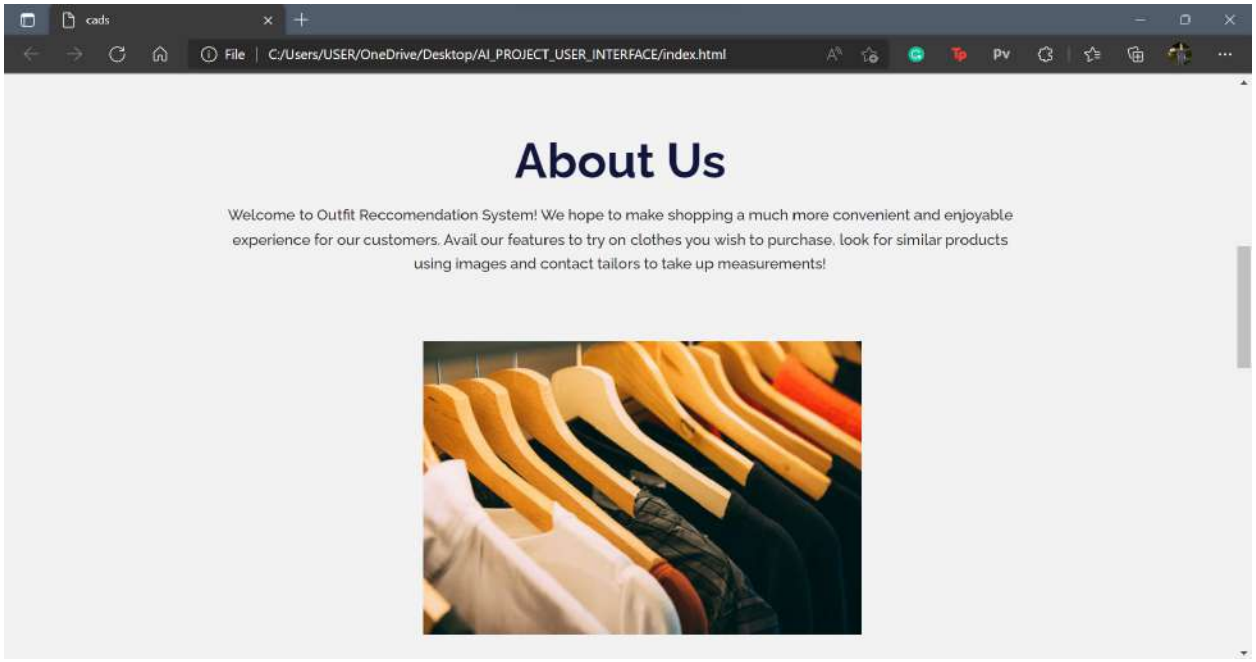
D) Business Model:

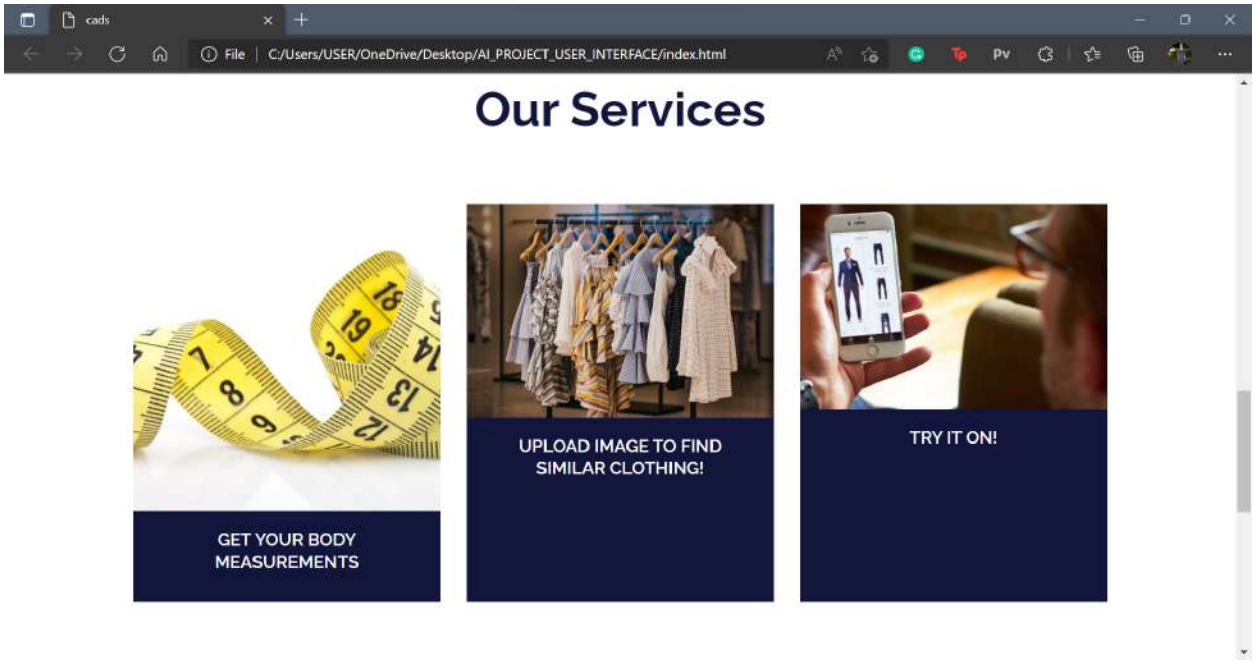
This platform provides the option to take measurements virtually and connect with tailors online. This functionality boosts customised online-cloth trade and commerce. It also helps build virtual-trial rooms. Customers can make use of this portal to get apparels altered by just uploading images of themselves, this will compute their measurements and find tailors. This makes the process of connecting with tailors much easier and benefits the tailors as well. This idea once implemented can be profitable.

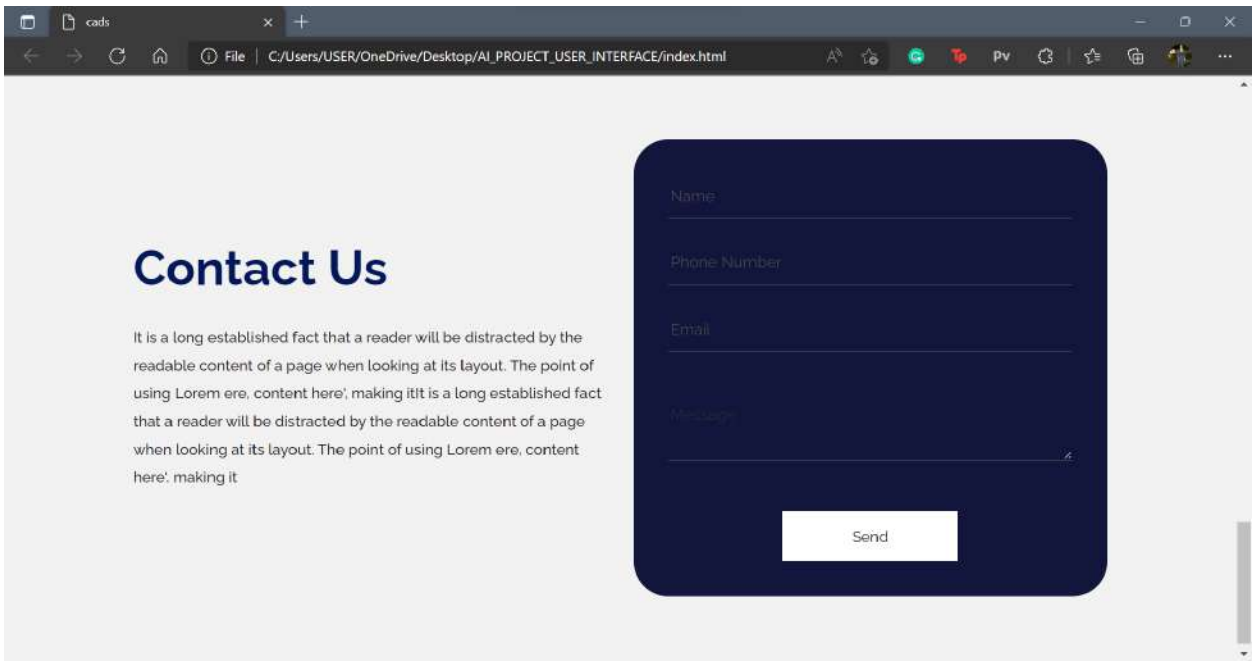
9. Implementation Results and User Interfaces (Explain each result and user interface)

USER INTERFACE:

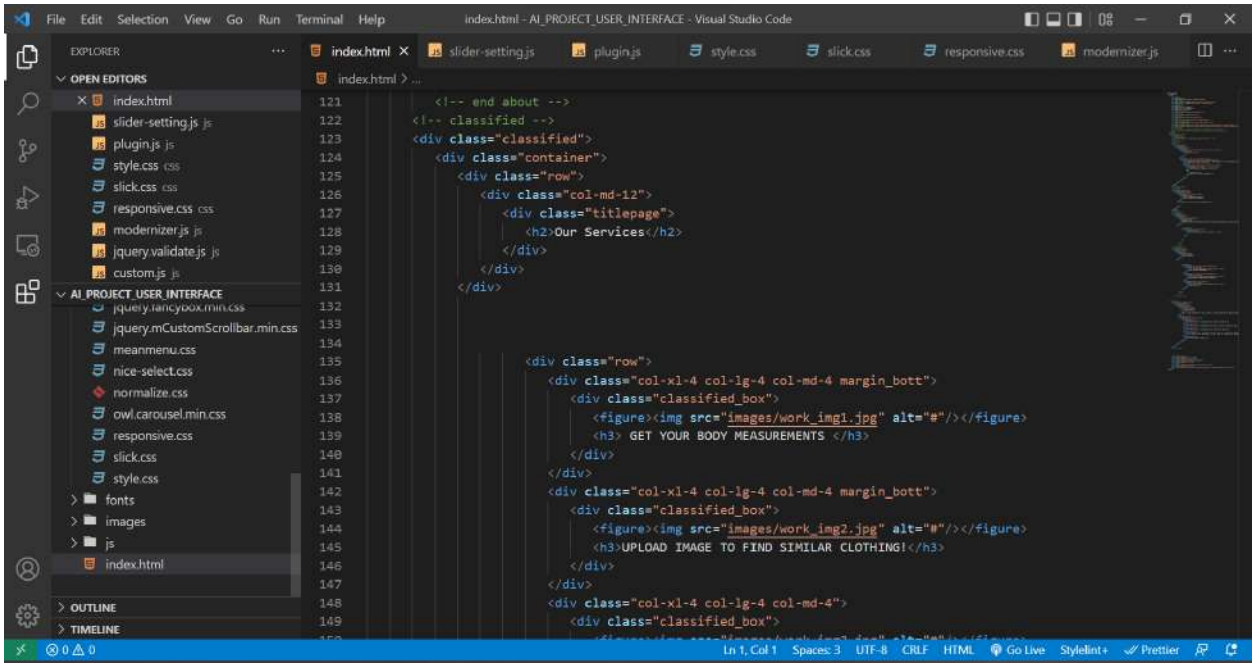





cads
File | C:/Users/USER/OneDrive/Desktop/AI_PROJECT_USER_INTERFACE/index.html
Our Services
GET YOUR BODY MEASUREMENTS
UPLOAD IMAGE TO FIND SIMILAR CLOTHING!
TRY IT ON!

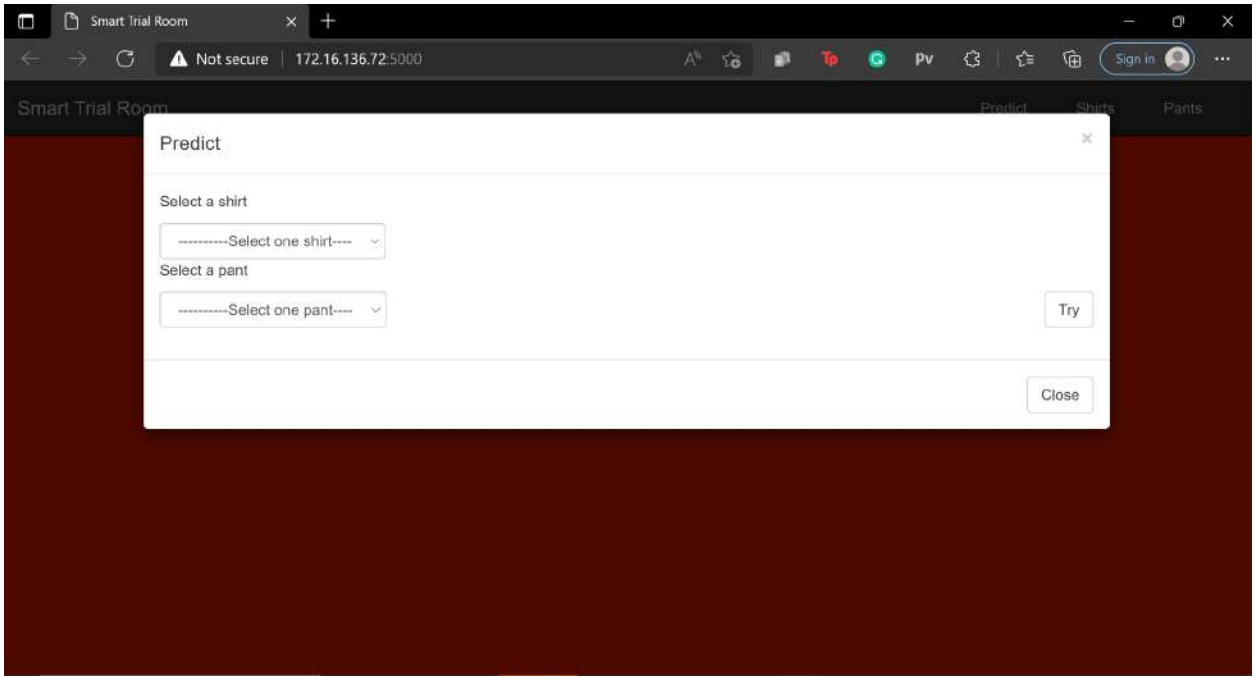

cads
File | C:/Users/USER/OneDrive/Desktop/AI_PROJECT_USER_INTERFACE/index.html
Contact Us
It is a long established fact that a reader will be distracted by the readable content of a page when looking at its layout. The point of using Lorem ere, content here', making itIt is a long established fact that a reader will be distracted by the readable content of a page when looking at its layout. The point of using Lorem ere, content here', making it
Name
Phone Number
Email
Message
Send

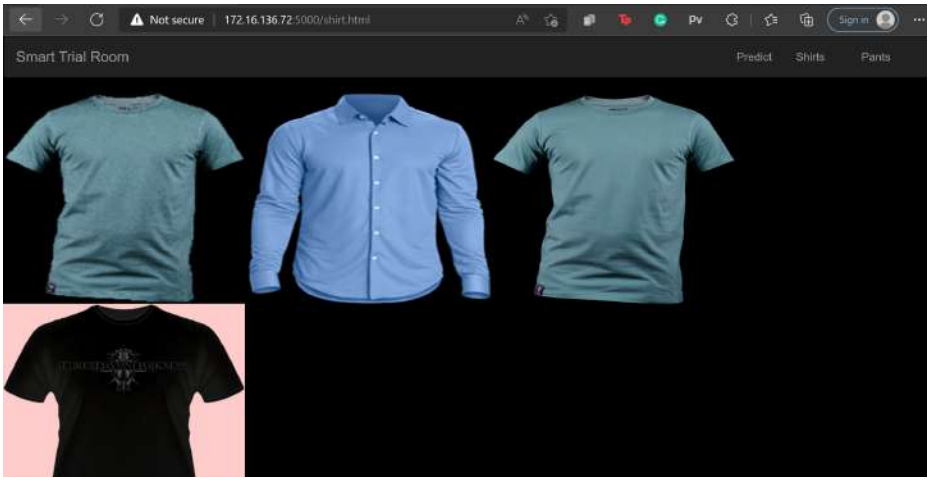
VsCode: UserInterface coding



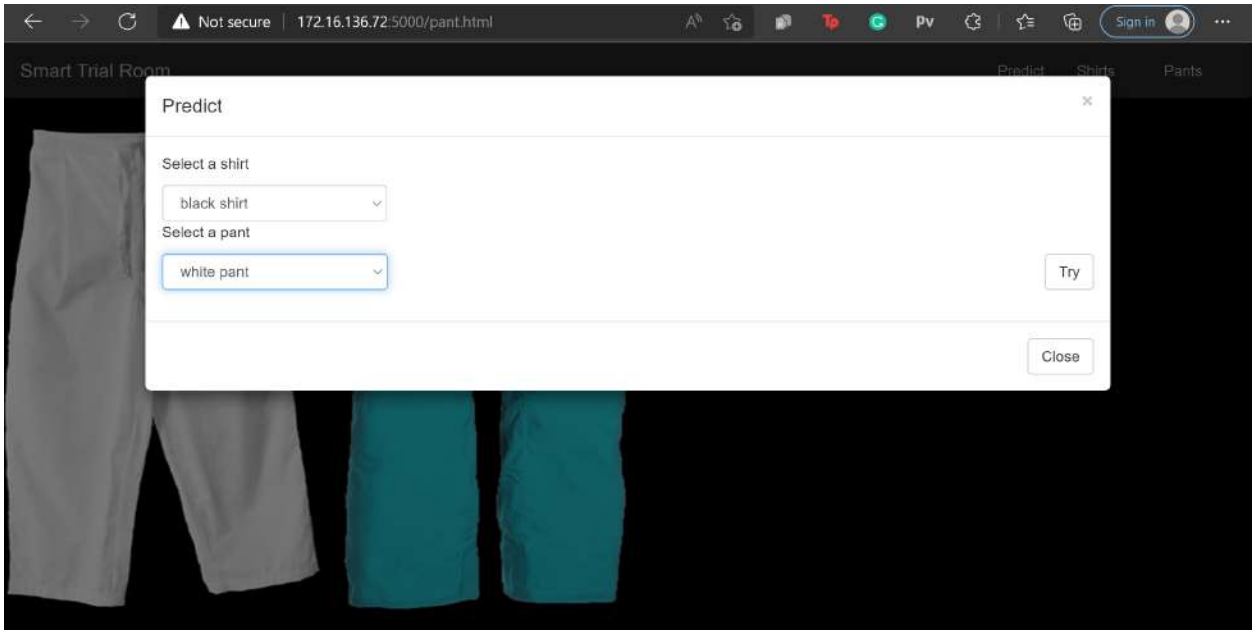
VIRTUAL TRIAL ROOM :

```
PS C:\Users\atlur\OneDrive\Desktop\vm\Virtual-Trial-Room> & C:/Python39/python.exe c:/Users/atlur/OneDrive/Desktop/vm/Virtual-Trial-Room/flasktry.py
 * Serving Flask app 'flasktry' (lazy loading)
 * Environment: production
   WARNING: This is a development server. Do not use it in a production deployment.
   Use a production WSGI server instead.
 * Debug mode: on
 * Restarting with watchdog (windowsapi)
 * Debugger is active!
 * Debugger PIN: 353-868-854
 * Running on all addresses.
   WARNING: This is a development server. Do not use it in a production deployment.
 * Running on http://172.16.136.72:5000/ (Press CTRL+C to quit)
```


Smart Trial Room
Not secure | 172.16.136.72:5000
Sign in
Smart Trial Room
Predict
Shirts
Pants
Predict
Select a shirt
----------Select one shirt----
Select a pant
----------Select one pant----
Try
Close


Not secure | 172.16.136.72:5000/shirt.html
Sign in
Smart Trial Room
Predict
Shirts
Pants


Smart Trial Room
Predict
Shirts
Pants


Not secure
172.16.136.72:5000/pant.html
Sign in
Smart Trial Room
Predict
Shirts
Pants
Predict
Select a shirt
black shirt
Select a pant
white pant
Try
Close

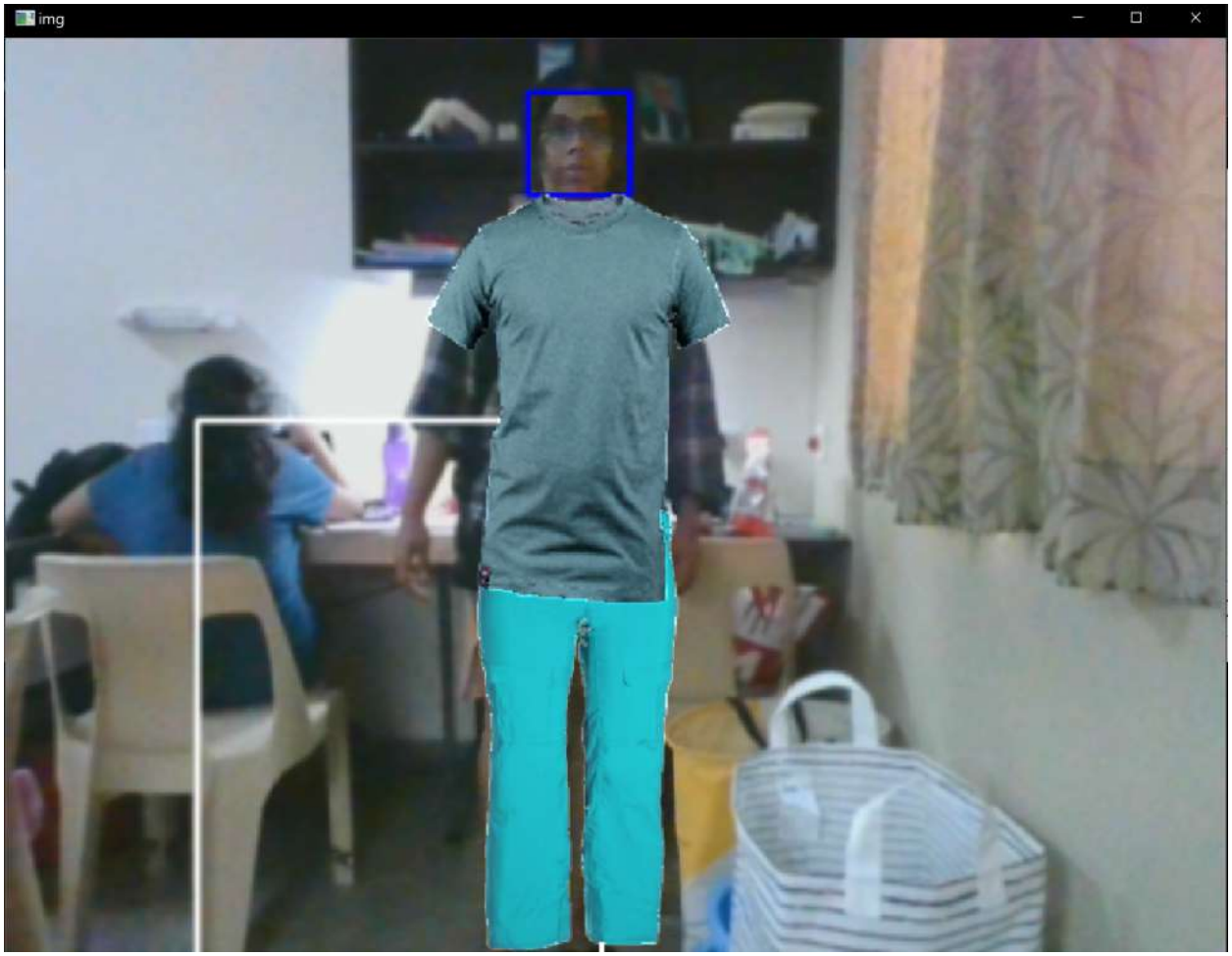
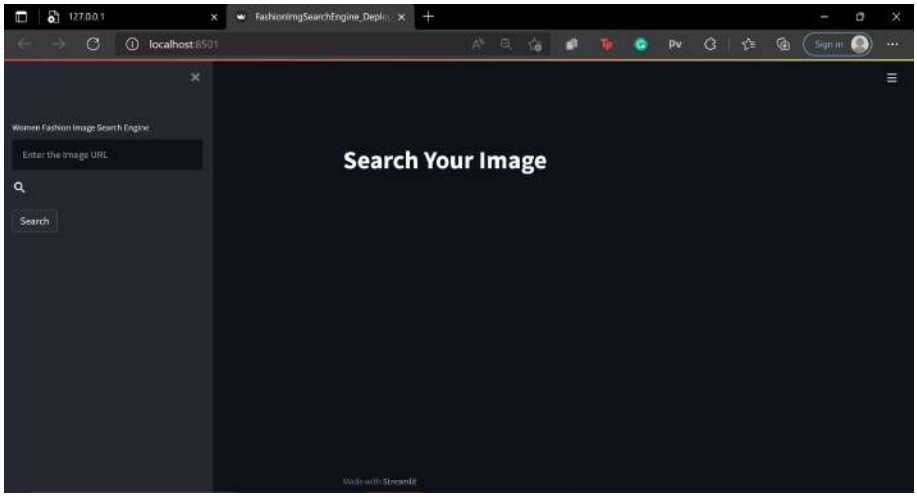

img

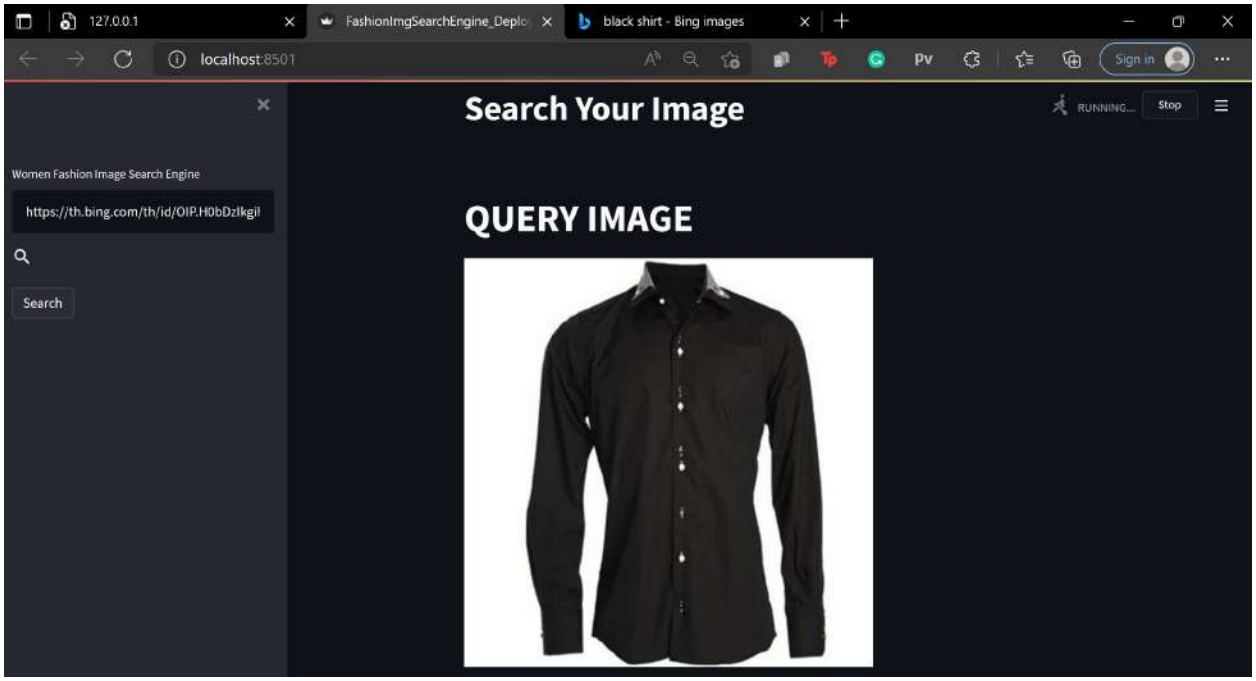
IMAGE SEARCHING :

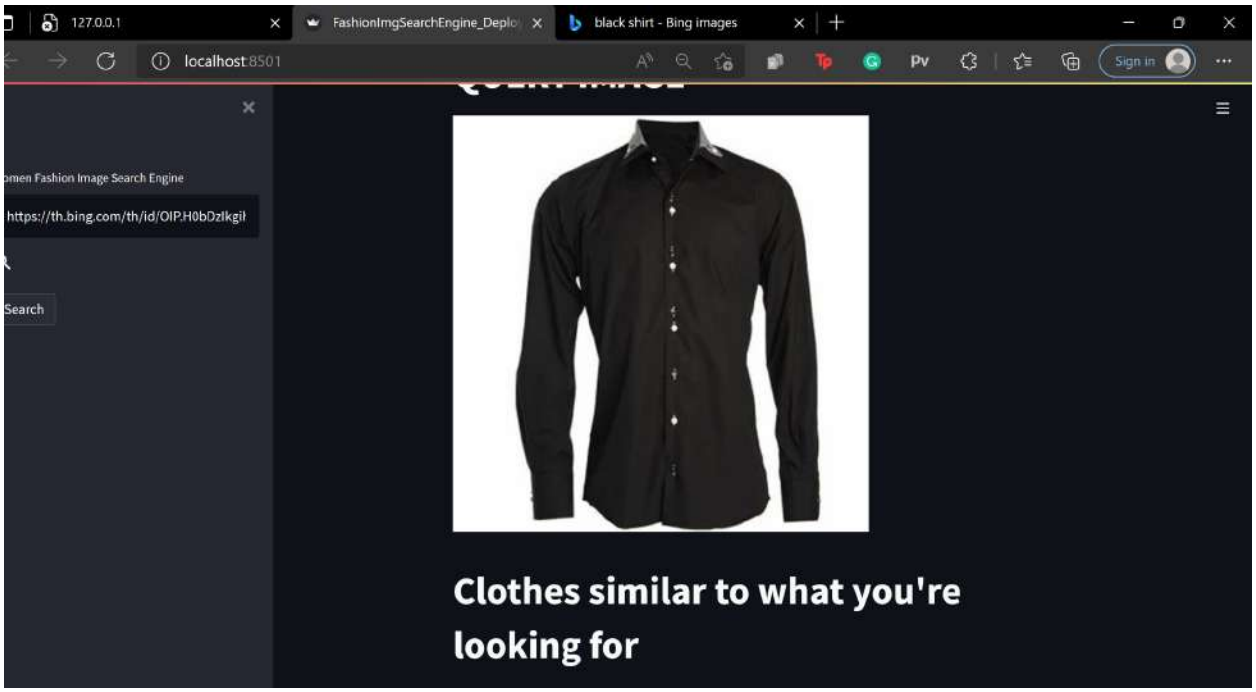
```
PS C:\Users\atlur\Downloads\Fashion-Image-Search-Engine-main\Fashion-Image-Search-Engine-main> streamlit run c:/Users/atlur/Downloads/Fash
ion-Image-Search-Engine-main/Fashion-Image-Search-Engine-main/FashionImgSearchEngine_Deployment.py
2022-04-29 13:00:44.019534: W tensorflow/stream_executor/platform/default/dso_loader.cc:64] Could not load dynamic library 'cudart64_110.dl
l'; dlerror: cudart64_110.dll not found
2022-04-29 13:00:44.020040: I tensorflow/stream_executor/cuda/cudart_stub.cc:29] Ignore above cudart dlerror if you do not have a GPU set u
p on your machine.

  You can now view your Streamlit app in your browser.

  Local URL: http://localhost:8501
  Network URL: http://172.16.136.72:8501
```

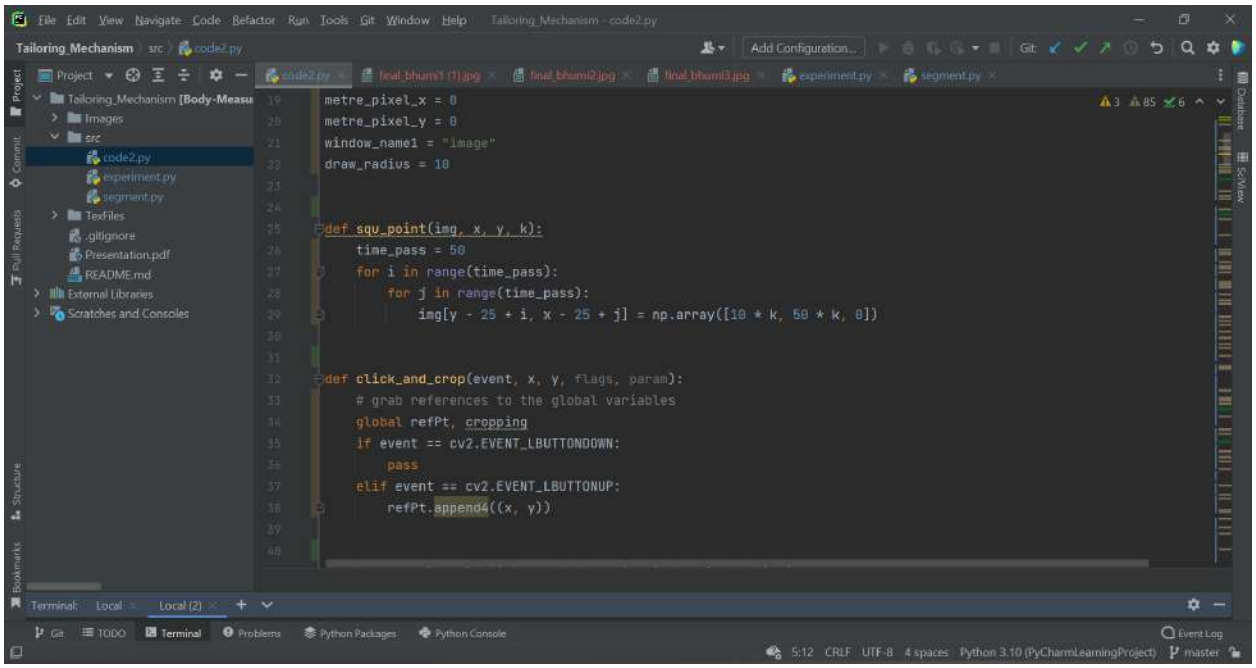




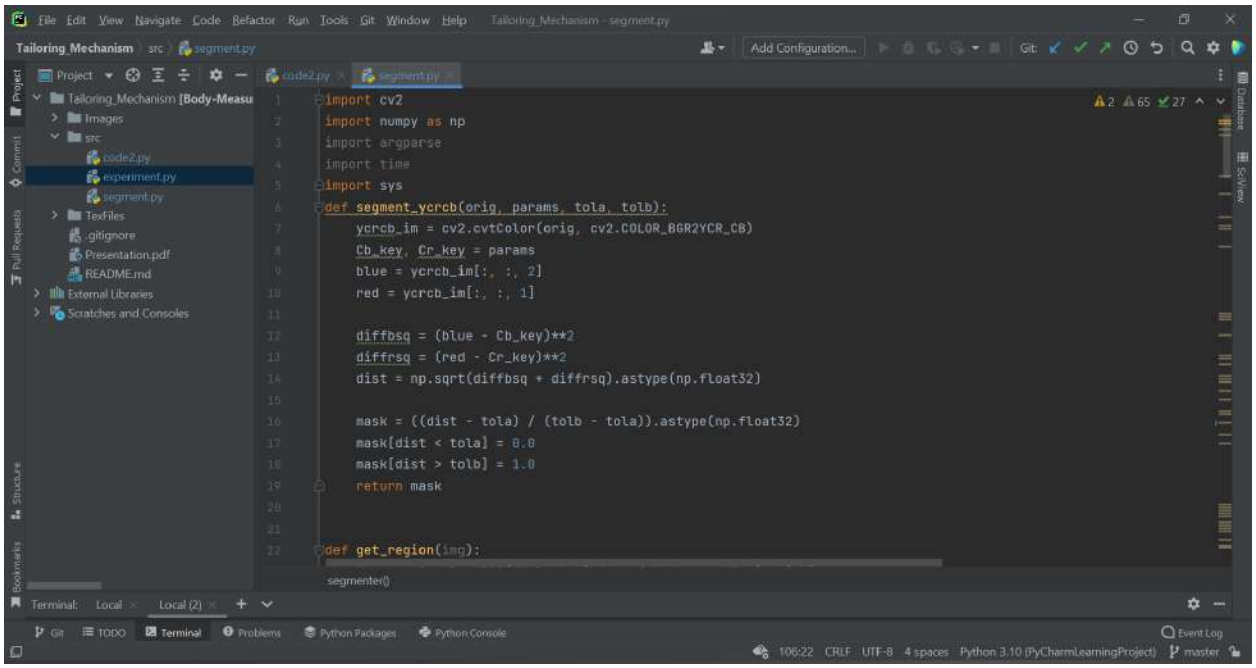


BODY MEASURMENTS :

code2.py



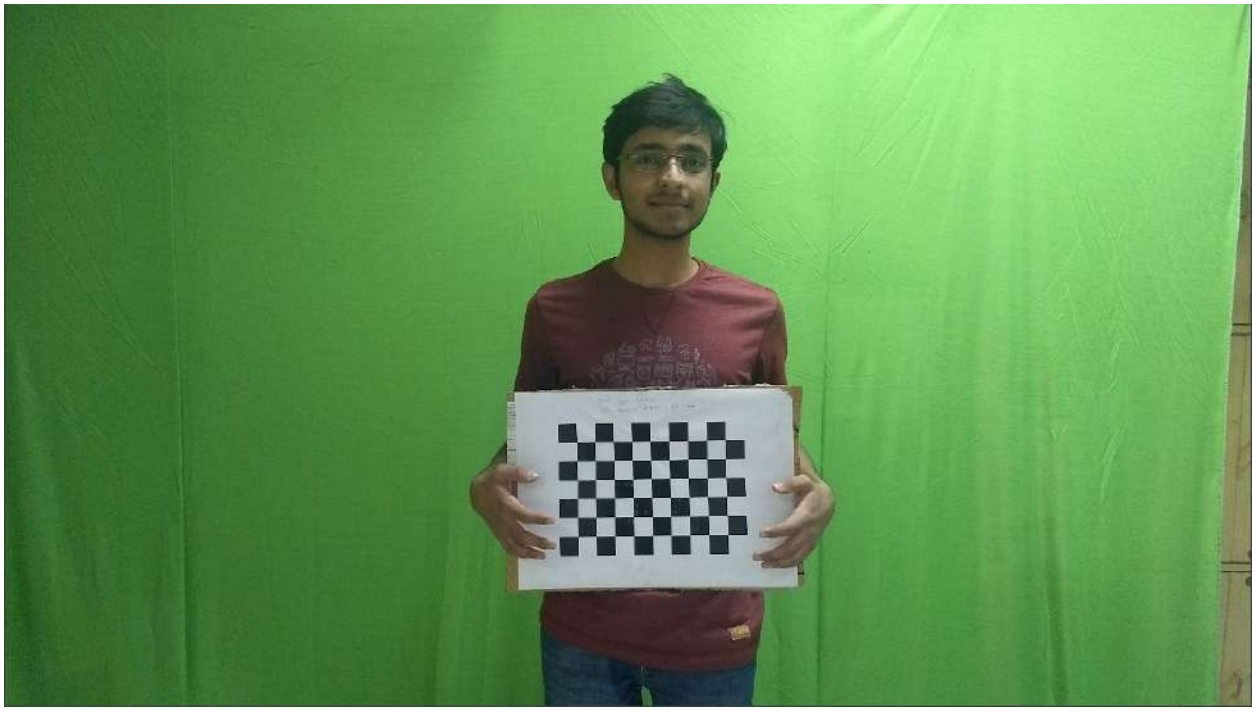
segment.py



Images used for output

1.(Known metric) - Image with Checker Board

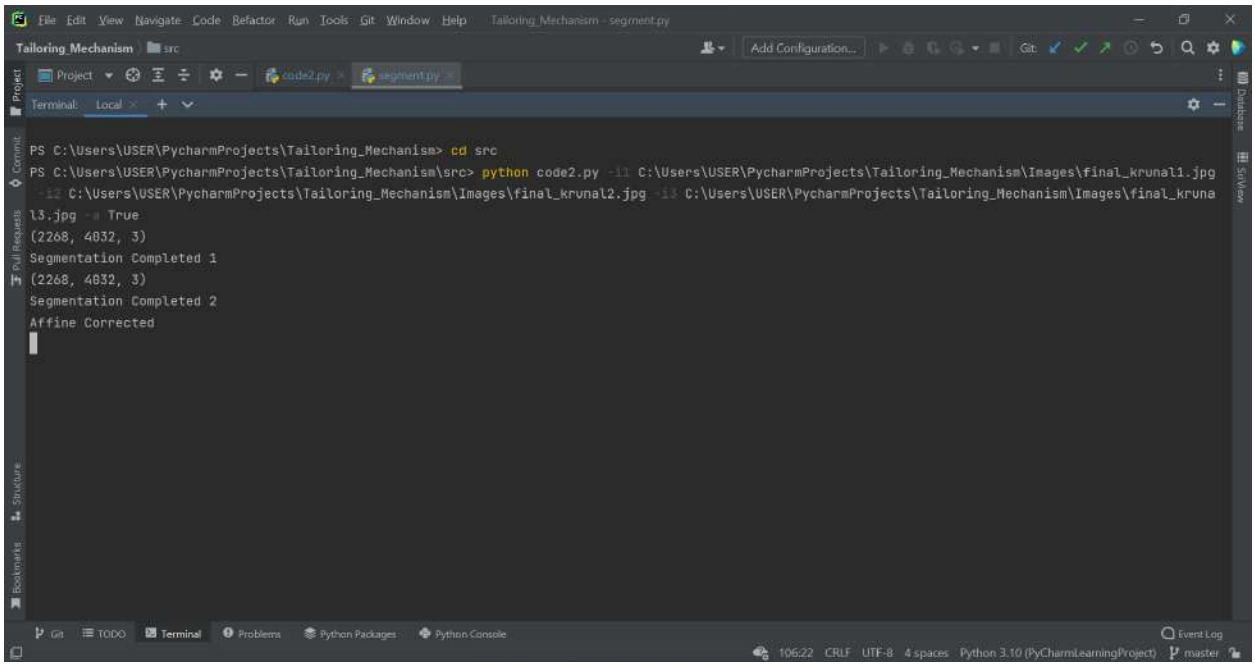
- **Used for measuring the shoulder distance**



2. This provide thickness of waist and helps complete waist measurement.

3. This helps in *wrist-to-shoulder* measurement, and provide width of waist's projection.

Affine Correction, Distance Calliberation and Grab Cut Segmentation performed

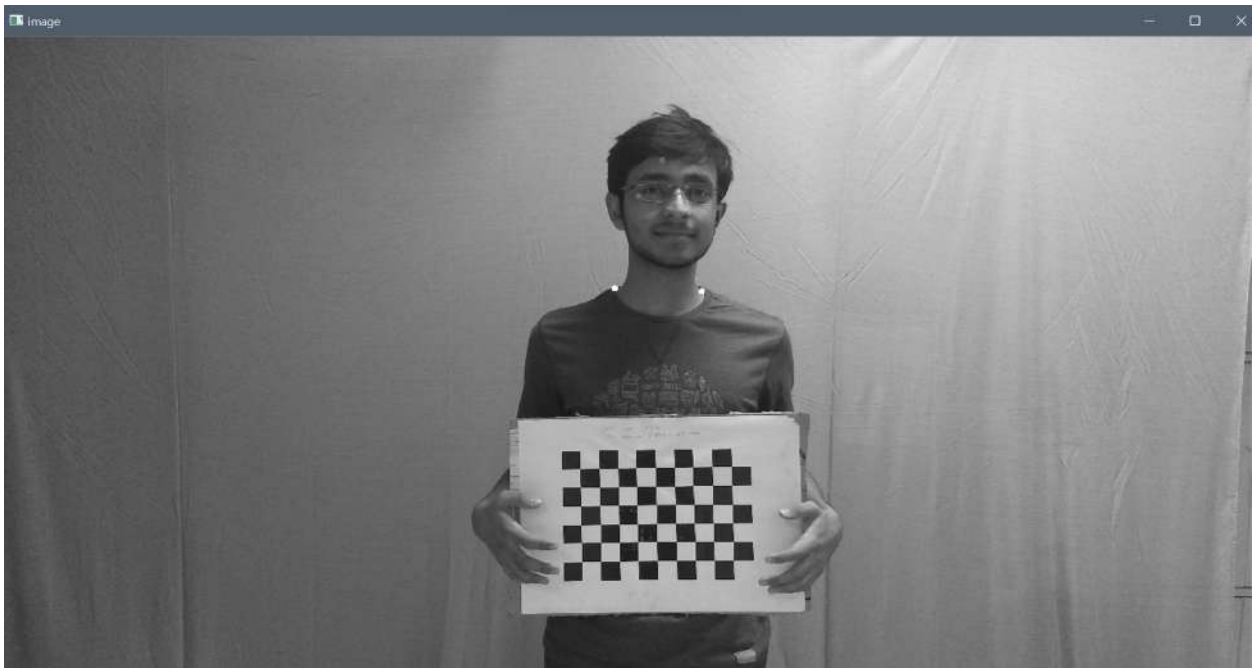


User Based Point Selection:

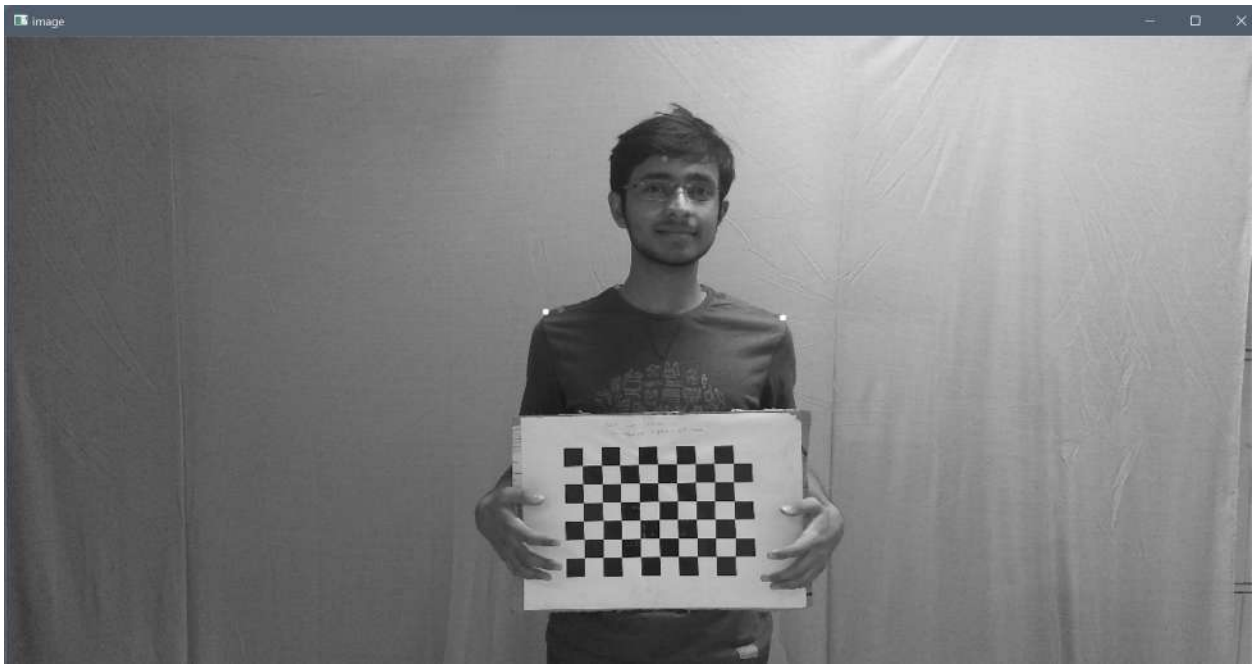
1. **For waist measurements: (points have been selected)**

2. **For waist measurements: (points have been selected)**

3. **For neck measurements: (points have been selected)**



4. **For shoulder measurements: (points have been selected)**



5. **For neck measurements: (points have been selected)(repeat for robustness)**

6. **For shoulder measurements: (points have been selected)(repeat for robustness)**

7. **Mark Wrists for wrist-to-shoulder measurements : (points have been selected)**

8. Body Measurements Obtained:

```
PS C:\Users\USER\PycharmProjects\Tailoring_Mechanism\src> python code2.py -i1 C:\Users\USER\PycharmProjects\Tailoring_Mechanism\Images\final_krunal1.jpg
 -i2 C:\Users\USER\PycharmProjects\Tailoring_Mechanism\Images\final_krunal2.jpg -i3 C:\Users\USER\PycharmProjects\Tailoring_Mechanism\Images\final_kruna
l3.jpg -a True
(2268, 4032, 3)
Segmentation Completed 1
(2268, 4032, 3)
Segmentation Completed 2
Affine Corrected
waist 87.08704198497048
Shoulder Length 36.249114747896215
Sleeve Length 52.47624316979031
PS C:\Users\USER\PycharmProjects\Tailoring_Mechanism\src>
```

10. Comparative Analysis with other existing technologies:

While other existing models consist of implementing single particular functionalities, this system consists of combining various important functionalities into one platform for the users to access. Moreover, this project aims to build a business model with our tailoring mechanism.
For our image searching approach, most of the existing projects or implementations include using KNN, we have used the Euclidean Distance approach to compute the distance between the uploaded image and the dataset images.
We have Green Screen Segmentation for our tailoring mechanism, most of the current mechanisms have used GrabCut Segmentation. The drawback for this is that the iterations are slow and tedious.

11. Conclusion & Future Scope:

AI strives to make our day-to-day tasks a little more efficient and a lot less difficult. In this project, we tried to combine three components using AI. We proposed a personalised tailoring mechanism system, in which the user can select his/her requirements from the filter provided and retrieve measurements of themselves. We also worked on image processing, using which we can try on the clothes based on the given filter, also image searching to find similar outfits.

We developed a user interface demonstrating the business model of the project. The future scope of this project can be using HTML and JavaScript to connect all of these functionalities into one working model and including a chatbot to connect with the tailors.

12. References

https://www.researchgate.net/publication/342435336_A_Comparative_Study_of_Outfit_Recommendation_Methods_with_a_Focus_on_Attention-based_Fusion

https://ieeexplore.ieee.org/document/8669792

https://cseweb.ucsd.edu/~jmcauley/pdfs/sigir15.pdf

http://yusanlin.com/files/papers/www20_OutfitNet.pdf

https://arxiv.org/ftp/arxiv/papers/1402/1402.6692.pdf
https://www.sciencedirect.com/science/article/pii/S1877050919321416/pdf?md5=5dbd63ead7bee387466468dde43aa38d&pid=1-s2.0-S1877050919321416-main.pdf

https://www.researchgate.net/publication/303601211_An_Approach_for_Clothing_Recommendation_Based_on_Multiple_Image_Attributes

https://www.irjet.net/archives/V6/i4/IRJET-V6I4870.pdf

(PDF) Fashion Recommendation Systems, Models and Methods: A Review

(PDF) A mobilized automatic human body measure system using neural network

https://www.researchgate.net/publication/319569282_Weather-to-garment_Weather-oriented_clothing_recommendation

https://www.atlantis-press.com/article/25880175.pdf

13. Appendix:

a. Link to PPT

https://www.canva.com/design/DAE3fxBl5bU/aFwzq4iYkGNGCgoYCUWEUQ/edit?utm_content=DAE3fxBl5bU&utm_campaign=designshare&utm_medium=link2&utm_source=sharebutton

b. Link to Pre-recorded Demonstration video

https://drive.google.com/drive/folders/1gJ5XUt-OHOdjU_5mfzeS2i1EmscLPZZX?usp=sharing

c. Link to access source files and file containing steps to execute the project

https://github.com/Bhumika0821/Fashion-Recommendation-System.git