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GARBGENIUS: AR APPROACH ENHANCING WARDROBE EXPERIENCE WITH RECOMMENDATION SYSTEM

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Abstract: In the fashion industry, finding well-fitting clothing that aligns with personal style preferences remains a significant challenge. Existing solutions, such as online shopping platforms, lack accurate prediction capabilities for how garments will fit for the individuals. To address this gap, GarbGenius proposes an innovative approach integrating Artificial Intelligence (AI) powered recommendation systems and Augmented Reality (AR) enhanced virtual try-on experiences. By leveraging user-image input submission and a comprehensive clothing datasets, GarbGenius will deliver personalized recommendations based on current fashion trends. Implementation involves developing user-friendly interfaces for user image input submission, clothing datasets, and algorithmic analysis of Vision Transformer (ViT) with recommendations, ensuring a seamless and immersive fashion wardrobe experience. Through iterative testing and maintenance, GarbGenius aims to empower users with confidence in exploring and embracing the latest trends tailored to their unique preferences.

Index Terms - Artificial Intelligence (AI) powered recommendation systems, Augmented Reality (AR), fashion trends, clothing datasets, algorithmic analysis, Vision Transformer.

I. INTRODUCTION

The fashion industry is characterized by its ever-changing trends and diverse consumer preferences which often possess unique challenges for both retailers and consumers. In this modern digital age, the proliferation of online shopping platforms has provided convenience and accessibility to the consumers worldwide. However, the inability to accurately predict garments fit and appearance remains a persistent issue, leading to dissatisfaction and increased return rates. To address these challenges, innovative solutions leveraging advanced technologies are imperative.

A. Overview of Fashion Retail Challenges

Traditional methods of purchasing clothes, whether in-store or online, often results in uncertainties regarding fit, style suitability, and overall satisfaction. Online shopping platforms, while they are convenient, lack the ability to provide accurate representations of garment fit on individuals, leading to a disconnect between consumer expectations and reality. Furthermore, existing recommendation systems fail to offer personalized suggestions based on evolving fashion trends and individual style preferences.

B. Motivations for GarbGenius Development

Our development of GarbGenius is motivated by the recognition of these pervasive challenges within the fashion retail landscape. By harnessing the capabilities of artificial intelligence (AI) and augmented reality (AR) technologies, GarbGenius seeks to revolutionize the way in which the consumers interact with enhanced fashion wardrobe experience. Our aim is to empower users with personalized recommendations tailored to their style preferences, and current fashion trends. By bridging the gap between consumer expectations and reality, GarbGenius endeavors to enhance user confidence, satisfaction, and engagement in the fashion wardrobe experience.

II. LITERATURE SURVEY

The paper "A Cost-Efficient Approach for Creating Virtual Fitting Rooms Using Generative Adversarial Networks (GANs)" describes a cost-effective method for developing a virtual fitting room using Generative Adversarial Networks (GANs). It addresses the challenges faced by customers during online shopping, particularly after the COVID-19 pandemic, and proposes the use of AI technologies to develop a virtual fitting room application for mobile devices and web platforms. The application allows users to try on clothing items virtually without the need for physical trials, thereby saving time and reducing crowding in physical stores. From a business perspective, the virtual fitting room is expected to increase online sales and preserve product quality. The method uses GANs and image processing techniques to generate output images from input images of a person and a clothing item. The results demonstrate superior performance compared to existing approaches in the literature. Enhanced Virtual Fitting Room highlights the enhanced virtual fitting room described in the paper addresses common challenges faced in traditional fit-on rooms, such as long queues, individual clothing changes, privacy issues, and time wastage. This convolutional neural network-based system utilizes deep learning and augmented reality to overcome these problems. It is equipped with a TV screen, two web cameras, and a computer to capture and display the customer's clad body. By leveraging CNN and AR technologies, the system accurately detects the customer's body and recommends clothing styles based on factors like age, gender, face type, and skin tone. It also allows for customization of styles according to customer preferences and achieves a high accuracy rate in suggesting different clothing styles using FFNN. Additionally, the system enables customers to select clothing for others who are not physically present. Overall, this innovative product has the potential to significantly impact the textile and fashion industry by providing efficient customization options and competing with other applications in the market.

Online Fitting Room: A Mobile buying Application Using Augmented Reality (AR) Technology suggests an online fitting room mobile application that makes use of Augmented Reality (AR) technology to address the issues of online clothing buying. It highlights the guesswork involved for customers who cannot physically try on clothes, leading to dissatisfaction and increased return rates for companies. By implementing an AR online fitting room, customers can virtually try on clothes in their actual environment and on their own bodies, using their fitting measurements for accuracy. This technology offers convenience, saving shoppers time and money by eliminating the need to visit physical stores. The paper emphasizes the potential impact of such an application on improving the online shopping experience for customers.

A study on consumer adoption of virtual fitting rooms for making purchasing decisions during e-commerce. This article presents research on customer acceptance of virtual fitting rooms for making purchasing selections during e-commerce. It describes the creation and evaluation of a virtual dressing room prototype, as well as a proposed research and testing strategy based on relevant usability and user experience studies. The experimental setup and execution of the usability and user experience tests are explained, followed by a presentation of the results and a discussion of their relevance to user-oriented design and virtual dressing room development.

Overview of the Augmented Reality Shopping System and Experience The architecture of an augmented reality (AR) shopping application that is presently being developed is reviewed in the literature. The system consists of a cloud server for object identification, localization, and the retrieval and analysis of product information, and a progressive web app client for rendering augmentations and tracking. The review finds design elements that are essential to the construction of the suggested system by looking at previous cloud-based augmented reality apps. The study advances knowledge of the technological specifications and factors required to create a successful augmented reality shopping experience.

III. EXISTING TECHNOLOGY

A. Virtual Fitting Room Technologies

Virtual Fitting Room Technologies encompass various methodologies for generating virtual representations of clothing items and facilitating try-on experiences. This includes employing image processing techniques to analyze and manipulate images, enabling the simulation of clothing items on users. Furthermore, machine learning and AI algorithms play a crucial role in customizing styles based on user preferences.

B. Augmented Reality (AR) Shopping Systems

Augmented Reality (AR) Shopping Systems leverage advanced technologies to enhance the shopping experience. This includes marker fewer tracking techniques, which enable the tracking of objects and surfaces in the real world without the need for markers or predefined patterns. Object recognition methods are also employed to identify and categorize products based on visual cues, facilitating interactive AR overlays and product information display.

C. Recommendation Systems

Recommendation systems in fashion retail are instrumental in enhancing user engagement and driving sales by providing personalized product suggestions tailored to individual preferences, browsing behaviors, and historical interactions. These systems use sophisticated algorithms, like content-based and collaborative filtering, to provide recommendations that suit each user's individual tastes for fashion, size, and style. Overall, recommendation systems play a vital role in revolutionizing the online fashion retail experience, offering tailored and engaging experiences while driving business growth and fostering customer loyalty.

IV. PROPOSED SYSTEM:

We present the innovative solution developed by GarbGenius to revolutionize the fashion retail experience. By combining cutting-edge technologies and advanced methodologies, GarbGenius seeks to resolve the issues raised in the literature review and give customers a smooth, customized purchasing experience.

A. Overview of GarbGenius Solution

This subsection provides an overview of GarbGenius's approach to enhancing the fashion retail experience. Key components include:

- **Integration of Virtual Fitting Room & Augmented Reality (AR) Technology:** GarbGenius leverages advanced image processing techniques and user-image input submission to create virtual fitting rooms that accurately simulate garment fit and appearance on the individuals. Along with, it integrates AR technology to provide users with interactive and immersive try-on experiences.
- **AI-Powered Recommendation System:** GarbGenius utilizes machine learning algorithms to generate personalized clothing recommendations based on current fashion trends.

B. Key Features and Functionality

Here, we detail the key features and functionality of the GarbGenius solution, including:

- **Virtual Try-On Experience:** Users can virtually try on clothing items in real-time, adjusting preferences to find the perfect outfit.
- **Personalized Recommendations:** GarbGenius provides tailored clothing recommendations based on current fashion trends.
- **Style Customization:** Users can customize clothing styles and combinations to reflect their fashion sense.

C. Technical Implementation

This subsection outlines the technical implementation of the GarbGenius solution, including:

- **Software Architecture:** GarbGenius utilizes a simplified software architecture consisting of a frontend interface developed using Tkinter - Python library for creating graphical user interfaces (GUIs). The frontend component serves as the user interface where users interact with the system, submit their images, and receive clothing recommendations.
- **Data Processing Pipeline:** GarbGenius involves the image analysis for extracting relevant features from user-submitted images, such as clothing preferences. Upon receiving the user's image input, GarbGenius utilizes image processing techniques to analyze the image and extract relevant information. This information is then used to generate personalized clothing recommendations for the user.

1. **Performance Evaluation:**

a, Evaluating Models

Accuracy is a key performance indicator used to gauge the percentage of correctly categorized cases when assessing the effectiveness of classification models.

Accuracy: Among all instances, accuracy is a critical indicator that shows the percentage of correctly identified cases.

$$\text{Accuracy} = \frac{TP+TN}{TP+FP+TN+FN}$$

b, MPV3D Dataset

Our project leverages the MPV3D Dataset, an extension of the MPV dataset, tailored for monocular-to-3D try-on applications. Comprising 6566 high-resolution image pairs, it includes diverse upper-body garments and corresponding front (Df) and back (Db) depth maps. These depth maps, generated using PIFuHD, serve as pseudo ground truth data for our M3D-VTON model. The dataset is split into a training set (5632 pairs) and a test set (934 pairs), with the latter shuffled for unbiased evaluation. This comprehensive dataset facilitates rigorous assessment of our model's performance and advances virtual try-on technology.

c, Fashion Product Images – Recommendation System

Our recommendation system capitalizes on a robust dataset sourced from the thriving e-commerce industry, comprising professionally captured high-resolution product images, multiple label attributes, and descriptive text elucidating product characteristics. Each product is uniquely identified by an ID, such as 42431, with styles.csv serving as a mapping file facilitating efficient retrieval. This file not only indexes all products but also provides insights into key product categories and their display names, enhancing the dataset's comprehensiveness. Leveraging this rich dataset, our recommendation system aims to deliver tailored suggestions and personalized recommendations, thereby enriching users' shopping experiences and facilitating informed decision-making.

d, Model Comparison

We evaluate the performance of our model against existing approaches using accuracy as the primary metric. The following table summarizes the accuracy achieved by different models:

Table 4.1: Comparison of Model Accuracy

CATEGORY	MODEL	ACCURACY
Existing Solutions	ResNet 50 with K-Nearest Neighbor (KNN)	75%
Our Solutions	Vision Transformer (ViT) with Cosine similarity	77.9%
	Vision Transformer (ViT) with Support Vector Machine (SVM)	80.8%

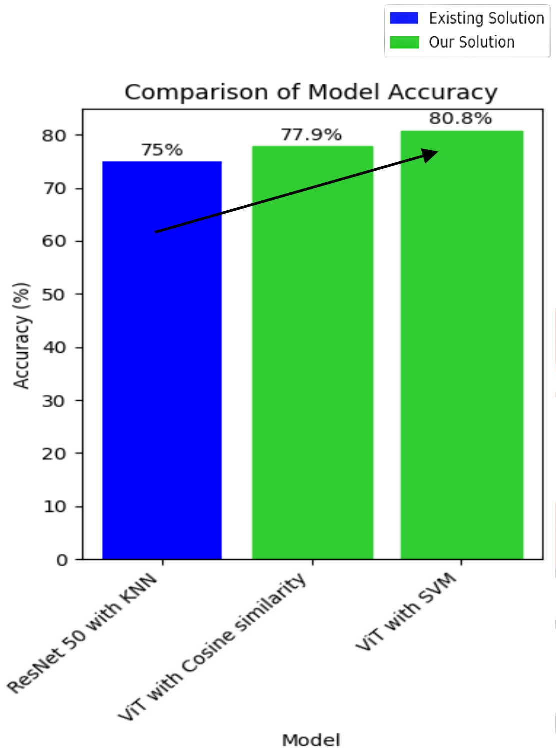


Fig 4.1 Model Comparison of Accuracy (Bar Chart)

By comparing the accuracy of our model with those of existing approaches, we can assess its effectiveness in correctly classifying instances and make informed decisions about its suitability for our application.

2. Algorithmic Foundations:

a, Virtual Tryon:

MPM: The Monocular Prediction Module (MPM) serves as the preparatory stage within our Virtual Try-On Network (VTON). Its primary objective is to facilitate subsequent modules by performing crucial tasks such as clothing warping, conditional person segmentation prediction, and base 3D shape estimation. MPM ensures that in-store apparel aligns onto the reference person while maintaining their identity by utilizing attributes that are taken from both the clothes-agnostic human representation and the target clothing.

DRM: Following the initial estimation of depth maps by MPM, the Depth Refinement Module (DRM) steps in to enhance the fidelity of the depth information. Understanding the constraints of the original depth map, DRM uses a unique method to improve the depth map by incorporating brightness changes in the preserved person section and the distorted clothing. By introducing a depth gradient constraint, DRM adds high-frequency details to capture intricate geometric features, such as clothing pleats and facial characteristics.

TFM: The Texture Fusion Module (TFM) is tasked with synthesizing photo-realistic body texture for the final 3D human mesh. Utilizing inputs including the preserved person part, warped clothing, predicted segmentation, and initial front depth, TFM ensures seamless integration of clothing texture with the person's appearance. Moreover, by considering body depth maps, TFM can synthesize try-on results with precision, even in challenging self-occlusion scenarios. The fusion mask generated by TFM facilitates the blending of clothing texture with the underlying person's features, ultimately yielding realistic try-on results.

b, Recommendation System:

The recommendation system in GarbGenius is built upon robust algorithmic foundations, employing advanced techniques for accurate and personalized clothing recommendations.

Vision Transformer (ViT): GarbGenius harnesses the power of Vision Transformer (ViT) algorithms for image feature extraction and analysis. ViT has demonstrated remarkable capabilities in handling large-scale image datasets and extracting meaningful features through self-attention mechanisms. By leveraging ViT, GarbGenius is able to analyze user-uploaded images and extract key visual features related to clothing items, such as patterns, colors, and styles.

DINO ViT: The DINO (Do It Yourself: No need to tear your hair Out) algorithm introduces a novel approach to enhancing Vision Transformer (ViT) models through self-supervised learning techniques. By leveraging self-supervision, DINO aims to improve the feature extraction capabilities of ViT models without relying on annotated data. Key components of the algorithm include momentum encoders, multi-crop training, cross-entropy loss, and a teacher-student network architecture. The momentum encoder, in particular, plays a crucial role in the training dynamics by constantly outperforming the student network and providing a form of Polyak-Ruppert averaging to guide the training process.

Support Vector Machine (SVM): In conjunction with ViT, GarbGenius utilizes Support Vector Machine (SVM) algorithms for classification tasks in the recommendation process. SVM is well-suited for binary classification tasks and is particularly effective in separating data points in high-dimensional feature spaces. By employing SVM, GarbGenius is able to classify user preferences and match them with relevant clothing items from the dataset.

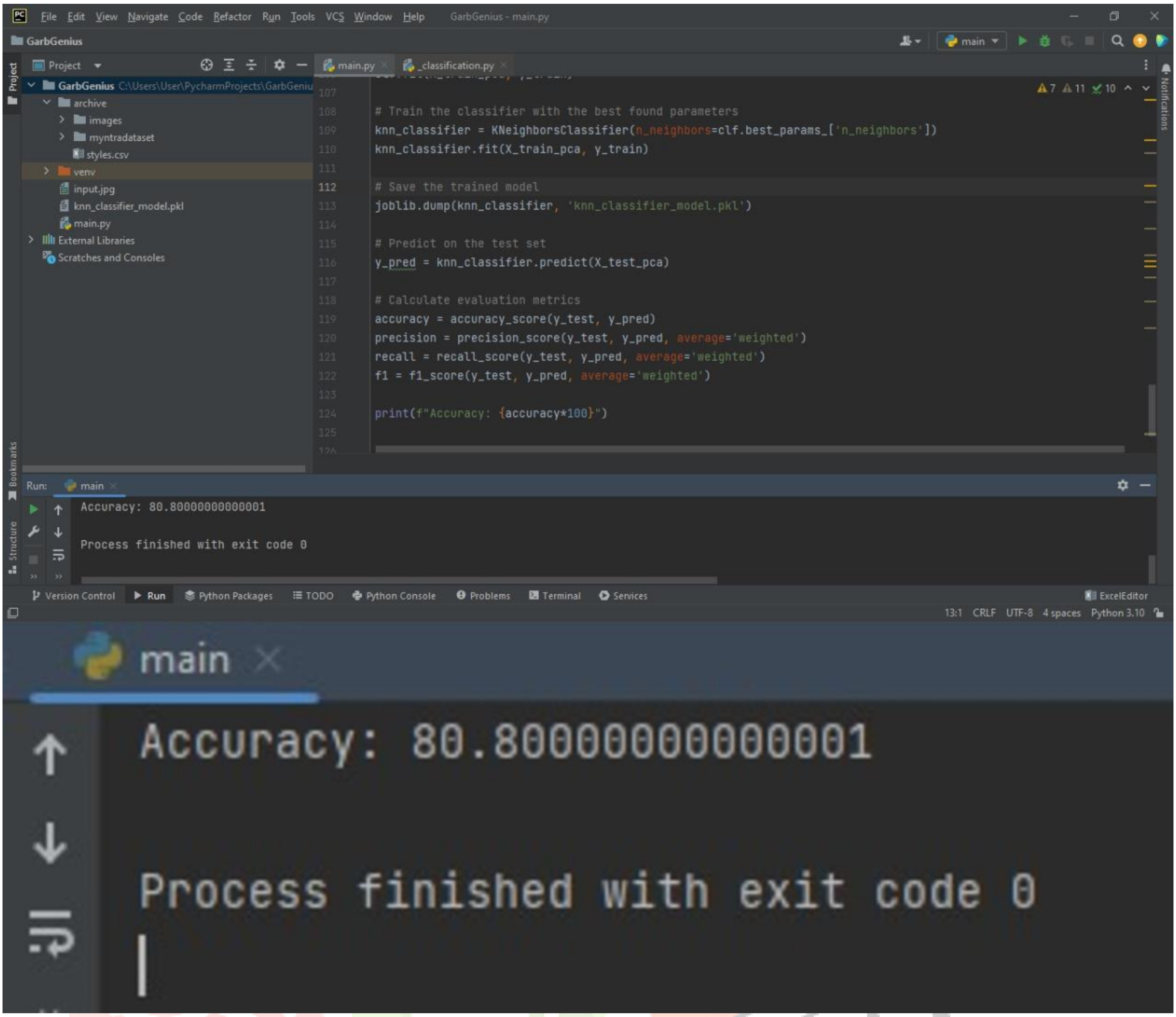


Fig. 4.2 Accuracy of Recommendation System with ViT

V. ARCHITECTURE

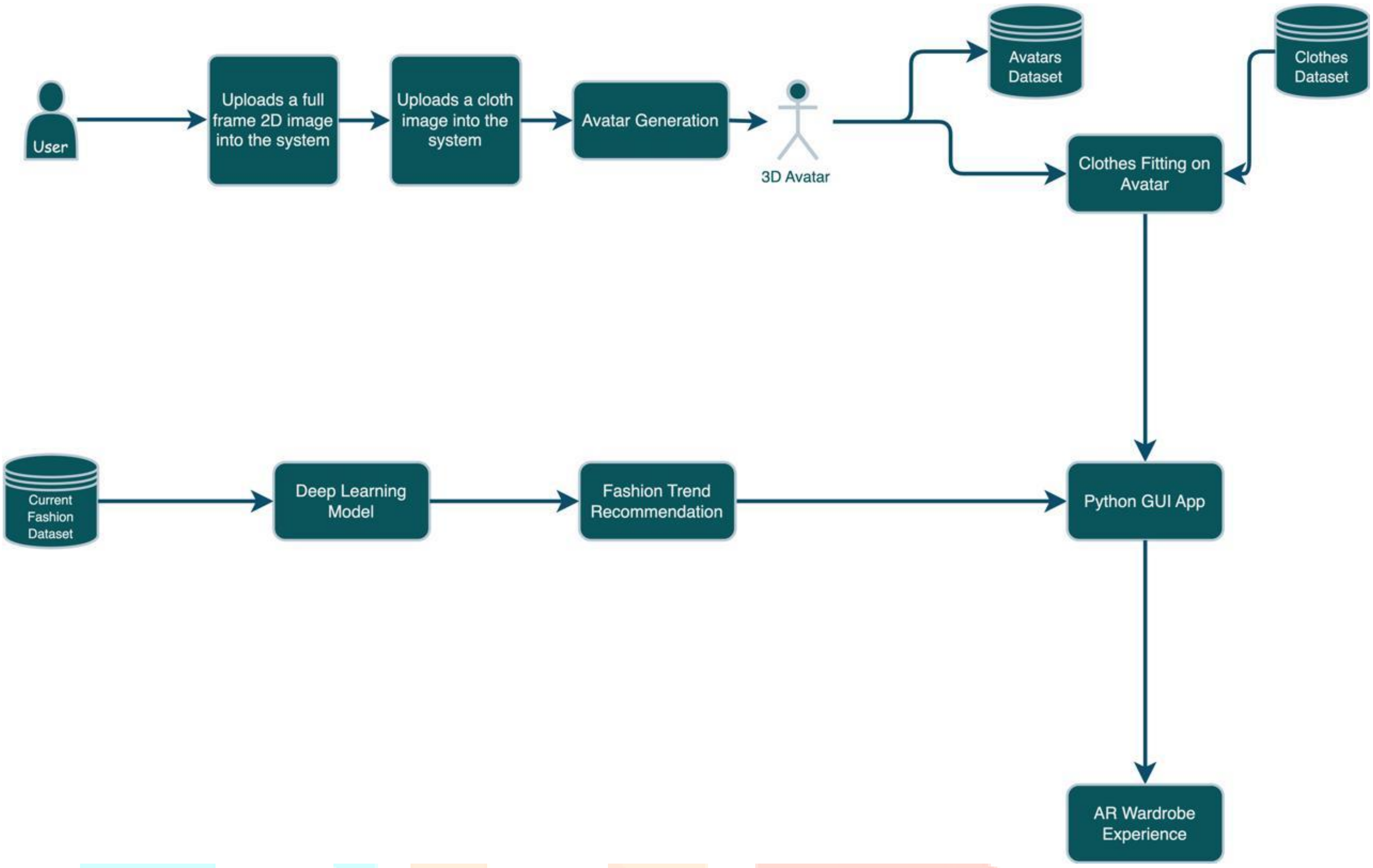


Fig 5.1: GarbGenius System Architecture

Following is the outline of the key modules comprising the GarbGenius system architecture, organized into user interaction, processing, data storage, and presentation modules.

A. User Interaction Modules:

- **Tkinter Interface**: Responsible for providing the graphical user interface (GUI) where users interact with the system.
- **Image Upload Submission**: Enables users to submit their 2D images for processing.

B. Processing Modules:

- **Clothing Recommendation**: Analyzes user-submitted images and matches them with items from the clothing dataset to generate personalized recommendations.
- **Pop-up Recommendation**: Displays recommended clothing items in a pop-up window upon image upload.

C. Data Storage Module:

- **Clothing Dataset**: Contains a collection of virtual clothing items available for recommendation.

D. MeshLab Module:

- **MeshLab**: Facilitates the export of processed results to MeshLab for viewing and further analysis.

DEMO SCREENSHOTS

Fig 5.2: GarbGenius User Interface

Fig 5.3: GarbGenius Input Image Submission

Fig 5.4: GarbGenius Cloth Image Selection – Recommendation System

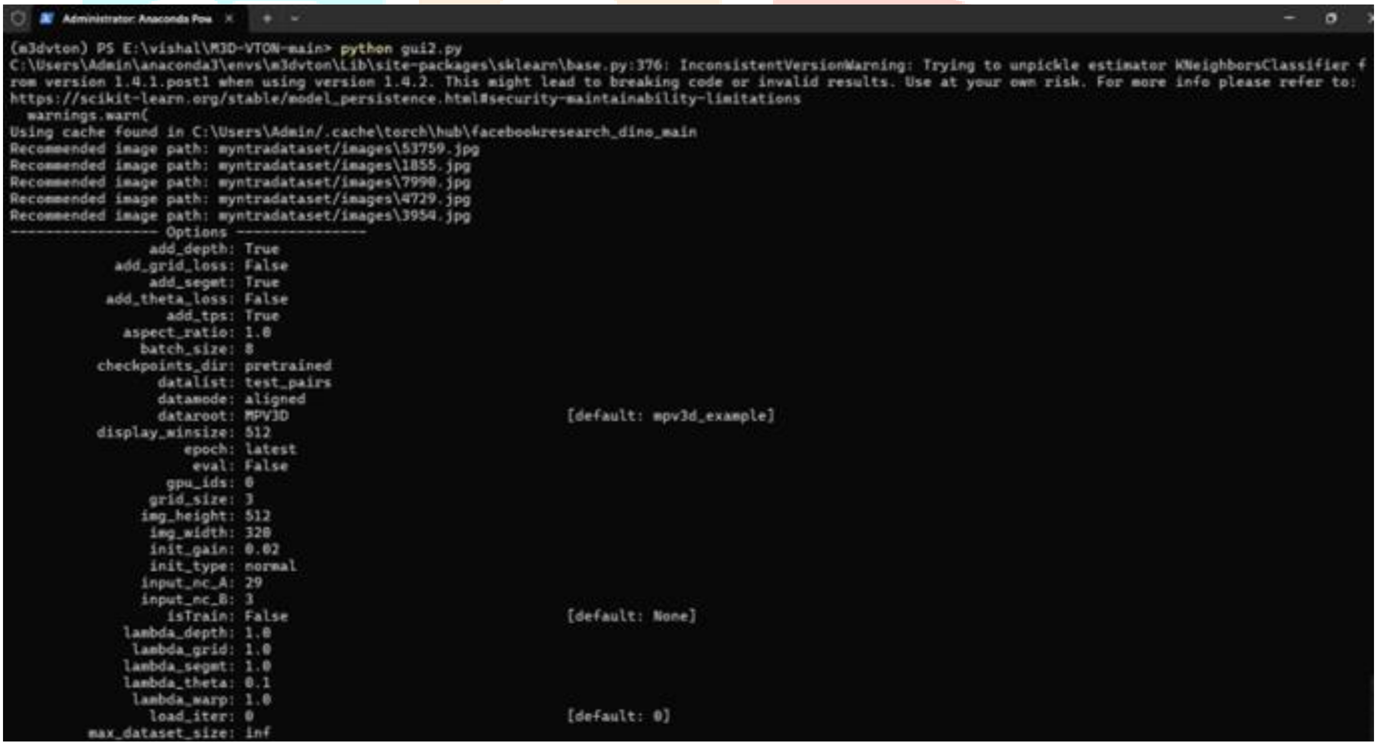
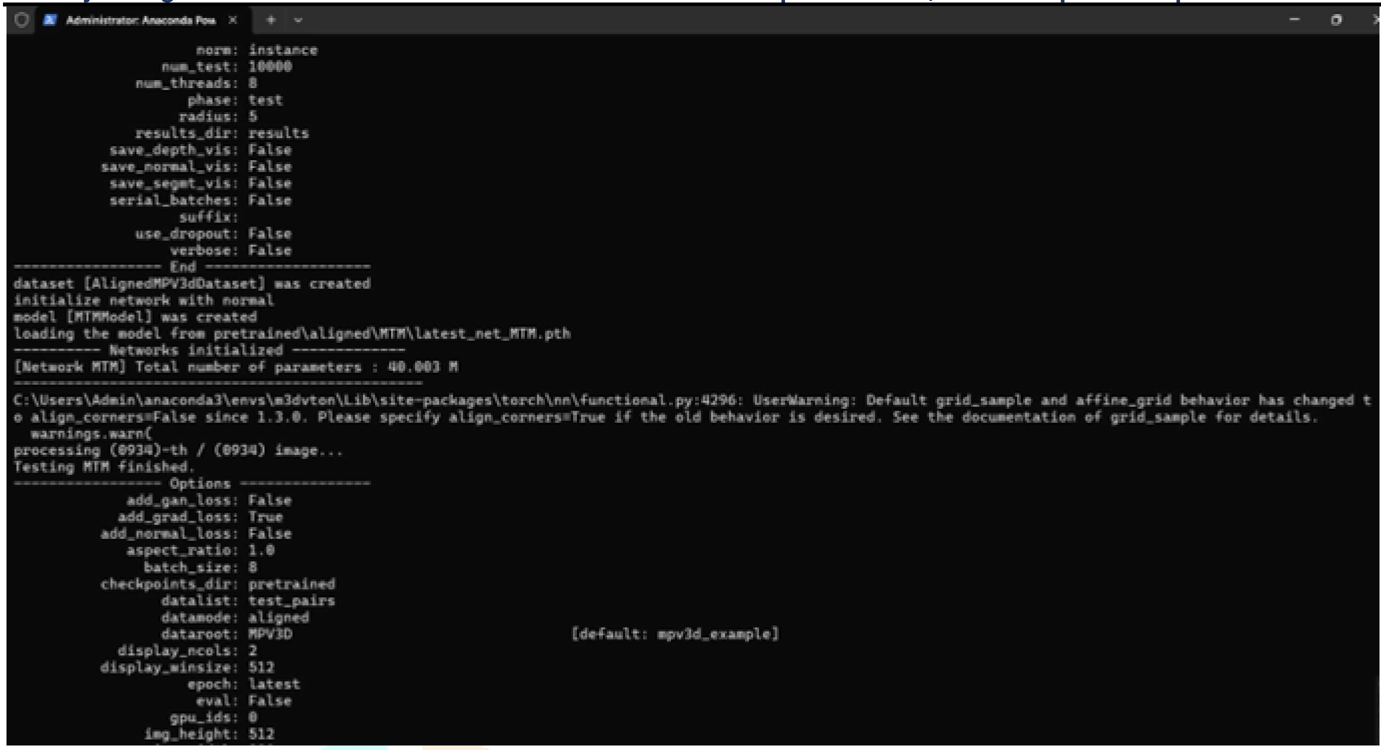
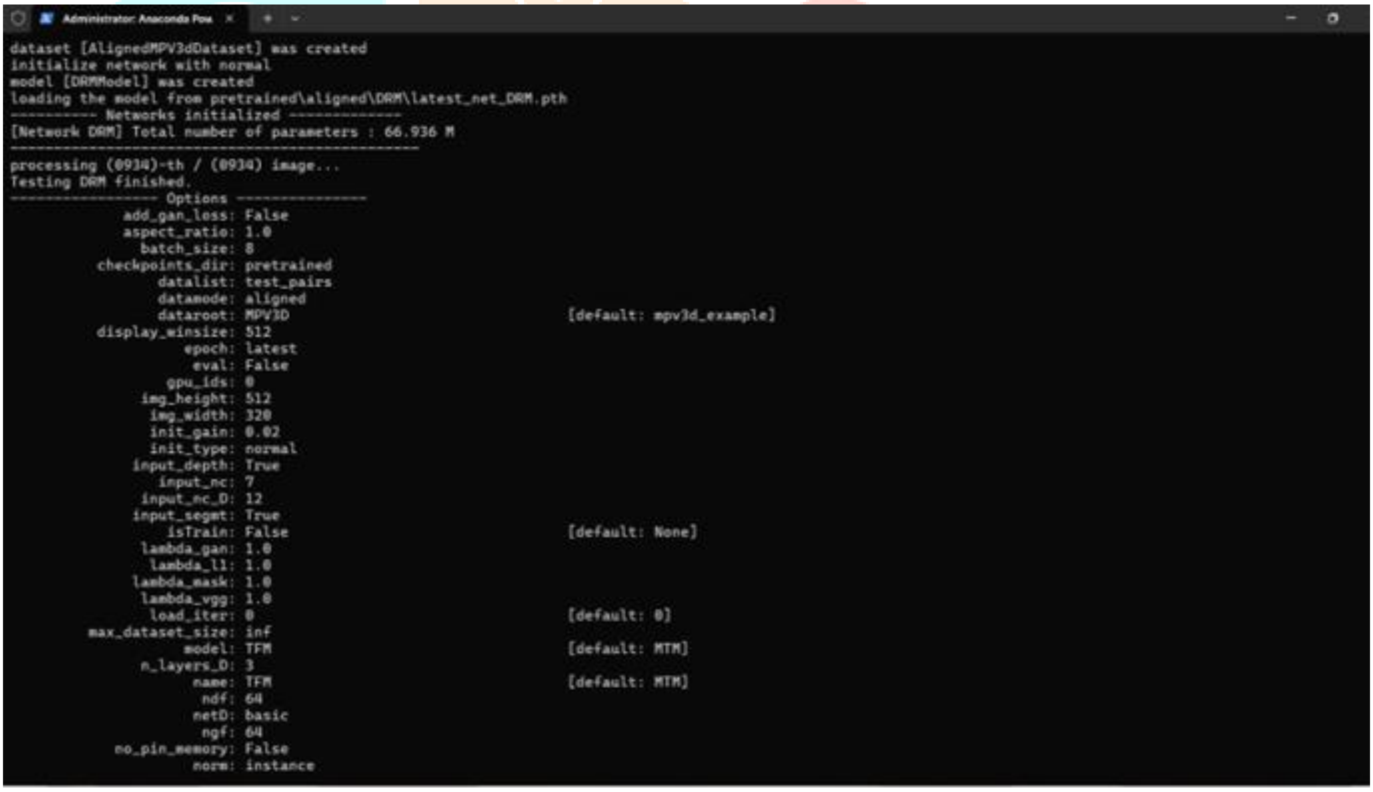


Fig 5.5: PowerShell Output



```
                  norm: instance
              num_test: 10000
           num_threads: 8
                 phase: test
                radius: 5
           results_dir: results
        save_depth_vis: False
       save_normal_vis: False
        save_segmt_vis: False
        serial_batches: False
                suffix:
           use_dropout: False
               verbose: False
----------------- End -------------------
dataset [AlignedMPV3dDataset] was created
initialize network with normal
model [MTMModel] was created
loading the model from pretrained\aligned\MTM\latest_net_MTM.pth
---------- Networks initialized -------------
[Network MTM] Total number of parameters : 40.003 M
-----------------------------------------------
C:\Users\Admin\anaconda3\envs\m3dvton\Lib\site-packages\torch\nn\functional.py:4296: UserWarning: Default grid_sample and affine_grid behavior has changed t
o align_corners=False since 1.3.0. Please specify align_corners=True if the old behavior is desired. See the documentation of grid_sample for details.
  warnings.warn(
processing (0934)-th / (0934) image...
Testing MTM finished.
----------------- Options ---------------
          add_gan_loss: False
         add_grad_loss: True
       add_normal_loss: False
          aspect_ratio: 1.0
            batch_size: 8
       checkpoints_dir: pretrained
              datalist: test_pairs
              datamode: aligned
              dataroot: MPV3D                         [default: mpv3d_example]
         display_ncols: 2
       display_winsize: 512
                 epoch: latest
                  eval: False
               gpu_ids: 0
            img_height: 512
```

Fig 5.6: PowerShell Output - MPM



```
dataset [AlignedMPV3dDataset] was created
initialize network with normal
model [DRMModel] was created
loading the model from pretrained\aligned\DRM\latest_net_DRM.pth
---------- Networks initialized -------------
[Network DRM] Total number of parameters : 66.936 M
-----------------------------------------------
processing (0934)-th / (0934) image...
Testing DRM finished.
----------------- Options ---------------
          add_gan_loss: False
          aspect_ratio: 1.0
            batch_size: 8
       checkpoints_dir: pretrained
              datalist: test_pairs
              datamode: aligned
              dataroot: MPV3D                         [default: mpv3d_example]
       display_winsize: 512
                 epoch: latest
                  eval: False
               gpu_ids: 0
            img_height: 512
             img_width: 320
             init_gain: 0.02
             init_type: normal
           input_depth: True
              input_nc: 7
            input_nc_D: 12
           input_segmt: True
               isTrain: False                         [default: None]
            lambda_gan: 1.0
             lambda_l1: 1.0
           lambda_mask: 1.0
            lambda_vgg: 1.0
             load_iter: 0                             [default: 0]
      max_dataset_size: inf
                 model: TFM                           [default: MTM]
            n_layers_D: 3
                  name: TFM                           [default: MTM]
                   ndf: 64
                  netD: basic
                   ngf: 64
         no_pin_memory: False
                  norm: instance
```

Fig 5.7: PowerShell Output - DRM

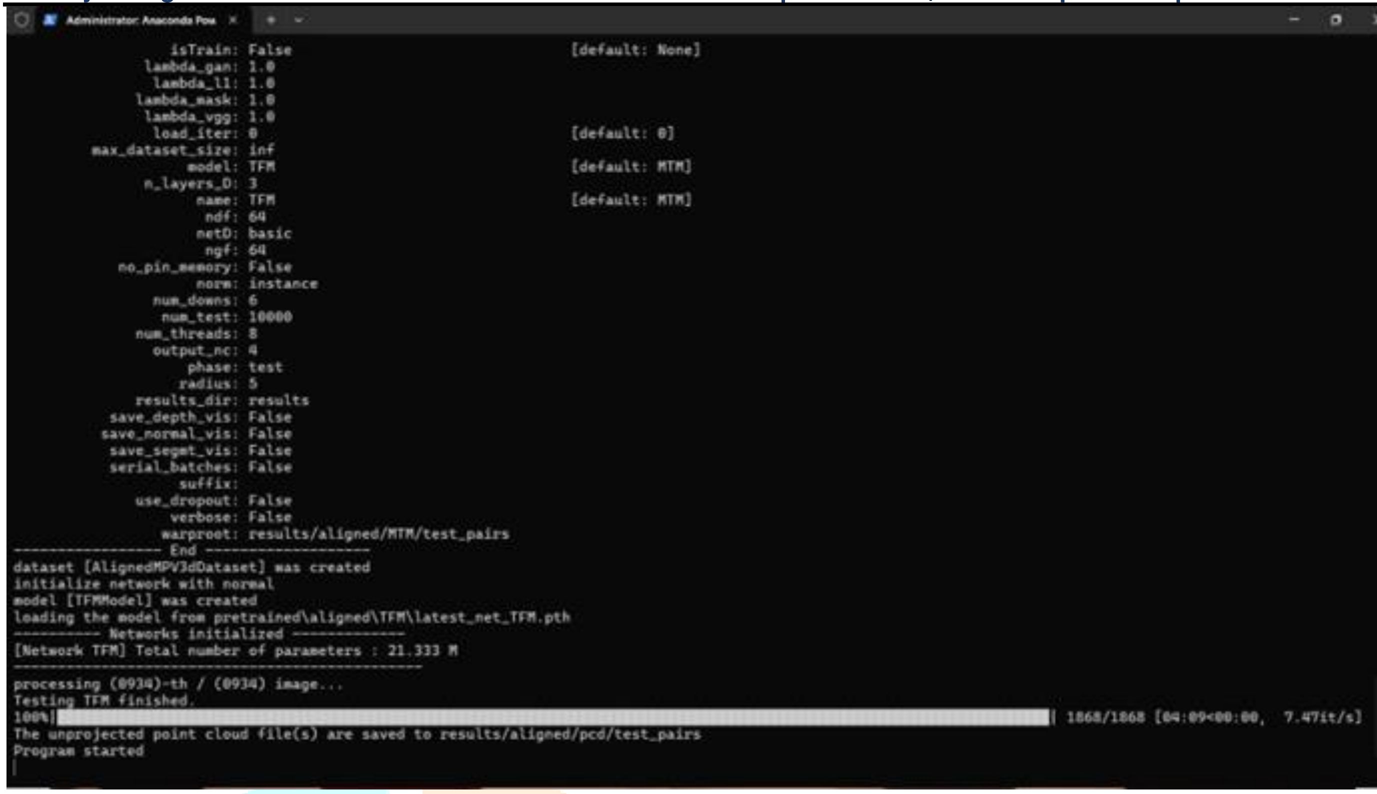


Fig 5.8: PowerShell Output – TFM

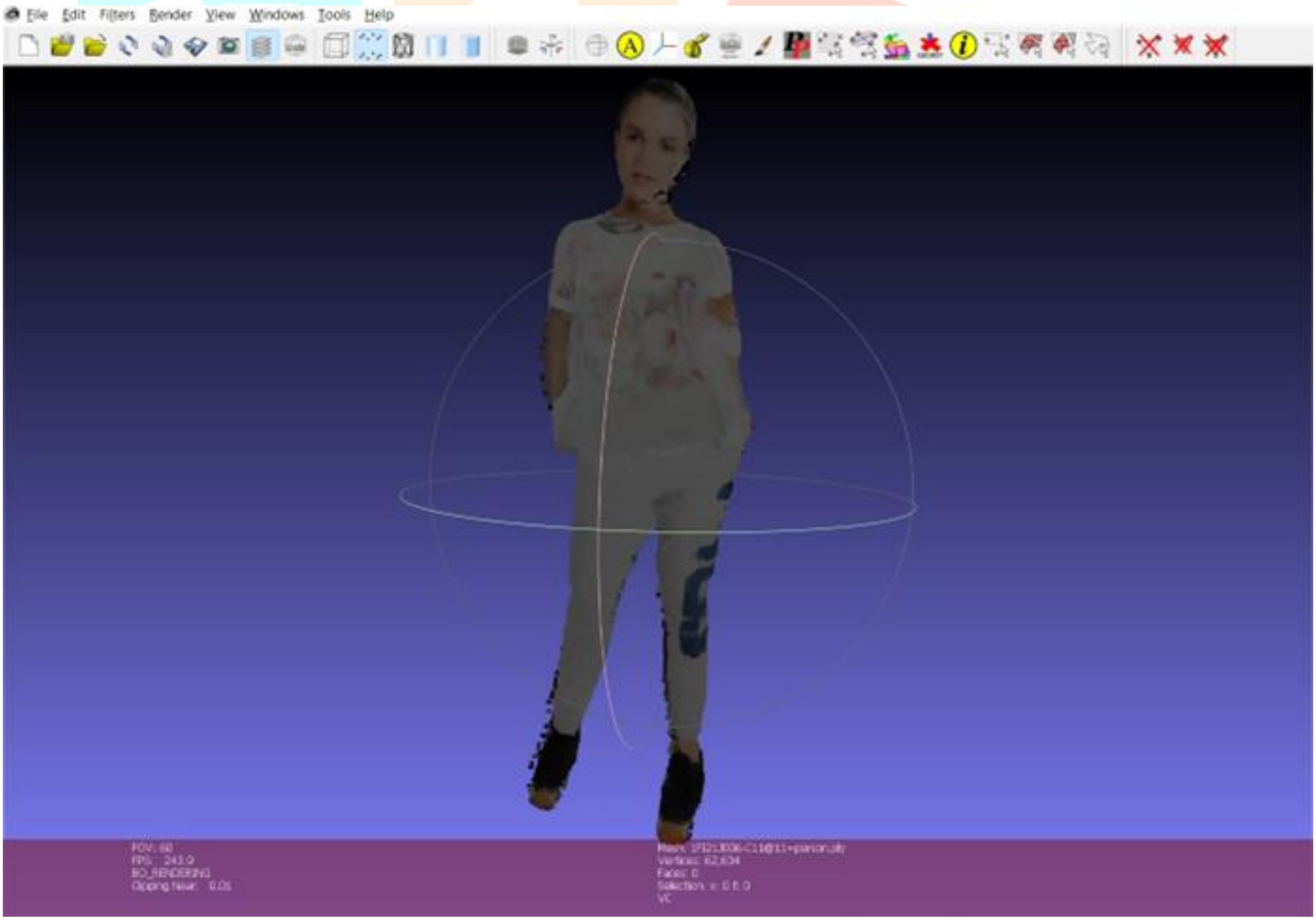


Fig 5.9: MeshLab Output

CONCLUSION

GarbGenius presents a promising solution to the persistent challenges faced by consumers and retailers in the fashion industry. By combining the state-of-the-art technologies such as Artificial Intelligence (AI) powered recommendation systems and Augmented Reality (AR) enhanced virtual try-on experiences, GarbGenius aims to revolutionize the fashion wardrobe experience, offering personalized solutions tailored to individuals with current trends. Through seamless integration of user-input image submission and a comprehensive clothing dataset, GarbGenius not only enhances the convenience of shopping but also contributes to reducing return rates and promoting sustainable fashion practices. With its focus on user-centric design and innovative approach, GarbGenius sets a new standard for immersive and inclusive fashion wardrobe experiences.

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