A

Project Report

On

WARDROBE PROJECTION

submitted in partial fulfillment for the award of

BACHELOR OF TECHNOLOGY DEGREE

in

Computer Science

By

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May 2024

DECLARATION

We hereby declare that this submission is our own work and that, to the best of our knowledge and belief, it contains no material previously published or written by another person nor material which to a substantial extent has been accepted for the award of any other degree or diploma of the university or other institute of higher learning, except where due acknowledgment has been made in the text.

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Date- May 25, 2024

CERTIFICATE

This is to certify that Project Report entitled "Wardrobe Projection" which is submitted by Prachi Verma and Pragati Tomar in partial fulfillment of the requirement for the award of degree B.Tech. in Department of Computer Science of Dr. A.P.J. Abdul Kalam Technical University, Lucknow is a record of the candidates own work carried out by them under my supervision. The matter embodied in this report is original and has not been submitted for the award of any other degree.

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Date: May 25, 2024

Supervisor's Signature:

Mr. Anurag Tewari

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ACKNOWLEDGEMENT

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ABSTRACT

Clothes are one of the top-selling products online, where demand for online shopping has skyrocketed in recent years. The issue with buying clothing online is that before making a purchase, customers cannot try the items on to see whether they are right for them. As a result, buyers find that trying on garments electronically is incredibly convenient. There have been several studies done on virtual try-ons using images. But the majority of them concentrate on attire and people from the front. They emphasize the person's and the clothing's front views. However, some approaches are available for different angles but we will work to increase the number of viewing angles for the attire and individuals. In order to enable virtual try-on without restricting the view direction of people or the target clothing, we wish to design a system that leverages photographs in a better way. It will allow users to create a clearer photo of themselves wearing the intended clothing by uploading both their personal photo and the intended clothing.

LIST OF FIGURES

LIST OF ABBREVIATIONS

1. **VITON**: Virtual Try-On Network. It's a technology or method used for virtual clothing try-ons.
2. **CAGAN**: Conditional Analogy Generative Adversarial Network. It's a type of machine learning algorithm used in the project.
3. **CGAN**: Conditional Generative Adversarial Network. It's a variant of Generative Adversarial Networks.
4. **GAN**: Generative Adversarial Network. It's a type of machine learning framework for generating synthetic data.
5. **CNN**: Convolutional Neural Network. It's a type of deep learning neural network often for image processing tasks.

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CHAPTER –1

INTRODUCTION

1.1 INTRODUCTION TO PROJECT

The advent of online shopping has revolutionized consumer behavior, particularly in the realm of fashion. Clothing stands as one of the top-selling commodities in the digital marketplace, with a burgeoning demand for virtual shopping experiences. However, one persistent challenge hampers this transition: the inability of consumers to physically try on garments before making a purchase. This limitation not only complicates the decision-making process but also contributes to higher rates of returns, impacting both consumers and retailers.

Moreover, the onset of the COVID-19 pandemic has further exacerbated these challenges, as traditional in-store try-on experiences have become less appealing due to health and safety concerns. Even as society transitions beyond the pandemic, consumer behaviors are expected to evolve, with a continued preference for alternative shopping experiences.

In response to these challenges, virtual try-on technologies have emerged as a promising solution. These technologies allow consumers to digitally project garments onto their own images, enabling them to visualize how clothing fits and looks without the need for physical interaction. While existing virtual try-on methods primarily focus on front-facing views, there remains a significant gap in accommodating different angles and perspectives.

Our project aims to address this gap by developing an innovative system that expands the range of viewing angles for both individuals and clothing items. By leveraging advancements in machine learning and computer vision, we seek to empower users to virtually try on clothing from various perspectives, thereby enhancing their shopping experience and reducing the inefficiencies associated with online apparel purchases.

Through the integration of cutting-edge technologies such as Virtual Try-On Networks (VITON) and Conditional Analogy Generative Adversarial Networks (CAGAN), our project endeavors to revolutionize the virtual shopping landscape. By providing users with a seamless and immersive try-on experience, we aim to drive engagement, increase conversion rates, and ultimately redefine the future of online fashion retail.

In summary, our project represents a pioneering effort to bridge the gap between traditional retail experiences and the burgeoning world of online shopping. By harnessing the power of technology, we aspire to empower consumers with greater choice, convenience, and confidence in their online apparel purchases.

1.2 PROJECT CATEGORY

The project "Wardrobe Projection" falls under the category of Computer Vision and Machine Learning applied in the field of Fashion Technology. This interdisciplinary domain combines elements of computer science, artificial intelligence, and fashion design to create innovative solutions for the fashion industry.

In this project, the team aims to address the challenge of online apparel shopping by developing a system that enables users to virtually try on clothing items before making a purchase. By leveraging machine learning algorithms and computer vision techniques, the system allows users to upload their personal photos along with images of the intended clothing items. The system then generates a composite image showing the user wearing the selected clothing item, providing a simulated try-on experience.

The project utilizes technologies such as Machine Learning, Deep Learning, Convolutional Neural Networks (CNN), and Generative Adversarial Networks (GAN) to achieve its objectives. These technologies enable the system to analyze and process images, recognize clothing items, and generate realistic virtual try-on results.

The interdisciplinary nature of this project involves aspects of fashion design, image processing, and user experience design. By integrating technology with fashion, the project aims to enhance the online shopping experience for users, improve conversion rates for clothing retailers, and address challenges such as the inability to try on clothes physically, especially in light of factors like the COVID-19 pandemic.

Overall, the "Wardrobe Projection" project represents an innovative application of computer science and machine learning principles in the fashion industry, offering a promising solution to the challenges of online apparel shopping.

1.3 OBJECTIVES

With the help of this project following objectives can be achieved:-

1. Enable Virtual Try-Ons: Develop a system that allows users to virtually try on clothing items before making a purchase, thereby enhancing their online shopping experience.

2. Expand Viewing Angles: Increase the number of angles in which users can upload their photographs, enabling them to view clothing items from various perspectives, including side angles, in addition to front views.

3. Enhance Image Clarity: Create clearer images of users wearing intended clothing by refining the output of virtual try-on algorithms, minimizing blurriness and improving detail representation.

4. Improve Usability: Enhance the usability of virtual try-on systems by integrating user-friendly features, such as intuitive interfaces and interactive functionalities, to streamline the try-on process and increase user satisfaction.

1.4 STRUCTURE OF REPORT

The project report has been divided into multiple chapters with each chapters getting divided into multiple sections and sub-sections.
Chapter 1 contains the introduction where a brief introduction of the project is stated. It also contains the category to which the project belongs to.
In Chapter 2, we have discussed the previous research work that has happened in this field as well as the problem statement. Apart from this, we have also mentioned the number of objectives that the system proposes to achieve.

Chapter 3 contains the detailed discussion of the project, its functionalities and the methodology used to create the proposed system. The various unique features of the project that differentiates this project with the existing ones, are also mentioned in the
designated section.

In chapter 4, we have performed the feasibility study and mentioned the various parameters and evaluated the system's technical, economical and operational feasibility. Along with this, we have also included the software requirement specification document that contains data requirement, functional requirement, performance requirement, maintainability requirement as well as security requirement.

This chapter also explains the Software Development Life Cycle (SDLC) model that has been used. It also illustrates the various diagrams like System Design using DFD. Level 0 and Level 1, Use Case Diagram and ER Diagram. Chapter 5 includes the implementation details of the proposed system. It mentions the languages, tools and technologies that have been used to create the system whereas.

Chapter 6 is dedicated to the testing and maintenance of the project. In Chapter 7, the results and discussion is done that contains the user interface representation, description of various modules of the project and snapshots of the system. The final chapter 8 is dedicated to the conclusion and future scope of the system. The project report concludes with the references section and research paper and
proof of patent publication.

CHAPTER – 2

LITERATURE REVIEW

2.1 LITERATURE REVIEW

Table 2.1 This table represent the methodologies and key findings of research paper

Sr. No	Reference	Year	Research Focus	Methodology	Key Findings
1	Learning-Based Animation of Clothing for Virtual Try-On.	2019	Mechanics of clothing in virtual try-on; Deformation modeling	Nonlinear regression models; Two-level approach for garment deformation	- Linear methodologies in existing data-driven technologies cause linear deformation in clothing.
2	VTNFP: An Image-based Virtual Try-on Network with Body and Clothing Feature Preservation	2019	Image synthesis for virtual try-on; Body and clothing intersection	Body segmentation map prediction module; Experiments with fashion dataset	- Generates photo-realistic virtual try-on images. Body segmentation map prediction module enhances image synthesis.

3	CP-VTON+: Clothing Shape and Texture Preserving Image-Based Virtual Try-On	2019	Addressing challenges in virtual try-on techniques	CP-VTON+ technique; Statistical and qualitative comparison	- Addresses difficulties in VTON techniques, such as misalignment and deformation.
4	The role of virtual try-on technology in online purchase decision	2019	Influence of virtual try-on on online purchase decisions	Advanced PLS techniques; Web-based survey approach	- Virtual try-on technology influences online purchase decisions based on utility, enjoyment, and risk perceptions.
5	The Role of Virtual Try-On and Physical Appearance in Apparel M-retailing	2019	Comparison of virtual try-on with physical appearance in online shopping	Theoretical framework based on Technology Acceptance Model; Online experiment and qualitative research	- Virtual try-on technology perceived as less pleasurable and convenient compared to conventional interfaces.
6	Image Based Virtual Try-on	2020	Virtual try-on network using	Outfit-VITON method;	- Outfit-VITON enables visualization of

	Network from Unpaired Data		unpaired data	Single image training phase	cohesive outfits from various reference images.
7	Effects of 3D Virtual ‘’Try-On’’ on Online Sales and Customers’ Purchasing Experiences	2020	Impact of 3D virtual try-on on online sales and customer experiences	Literature review; Importance of human body dimension estimation	- Virtual try-on technology saves time and helps in decision making, potentially reducing return rates. - Highlights the importance of human body dimension estimation.
8	Virtual Fashion Mirror	2020	Learning-based clothing animation for virtual try-on simulations	Recurrent neural network; Efficient cloth animation method	- Learning-based clothing animation method for efficient virtual try-on simulations.
9	From 2D Photos of Yourself to Virtual Try-On Dress on the Web	2021	Role of computer vision and AI in virtual try-on; Progress	Overview of 110 relevant articles; Categorization	- Rapid progress of computer vision and AI enables fashion-related

			in fashion-related AI applications	of research progress	applications like virtual try-on.
10	Anthropometrical Virtual Try-on: A Survey on Virtual Try-ons and Human Body Dimension Estimation	2022	Augmented reality technologies in virtual try-on; Human body dimension estimation	Overview of AR fashion display and smart mirror technologies	- Augmented reality technologies streamline the shopping process. Smart mirrors aid in virtual try-on experiences.

2.2 RESEARCH GAPS

1. Inadequate Realism in Clothing Deformation: Existing virtual try-on techniques often rely on linear methodologies for simulating clothing deformation, resulting in creases that appear linear and unrealistic. There is a gap in the literature regarding more sophisticated methods for simulating nonlinear garment deformation to achieve greater realism in virtual try-on applications.

2. Lack of Body-Clothing Interaction Understanding: While some virtual try-on networks generate photo-realistic images, there is still a gap in understanding the complex interaction between the human body and clothing items. Current approaches may not adequately

preserve body and clothing features, leading to misalignments and distortions in virtual try-on results.

3. Need for Improved Clothing Warping Networks: Existing image-based virtual try-on techniques face challenges related to incorrect clothing-agnostic human representations, mismatched input images, and poor composition-mask generation. There is a gap in the literature for more robust clothing shape and texture preserving methods that can overcome these challenges and produce more accurate try-on results.

4. Limited Understanding of User Perception and Behavior: While virtual try-on technology has gained popularity in online shopping, there is a gap in understanding how users perceive and interact with virtual try-on systems. Research is needed to explore the effects of virtual try-on technology on online purchase decisions, including the influence of perceived utility, enjoyment, and privacy risk on user behavior.

5. Integration of Anthropometric Data in Virtual Try-On: Virtual try-on systems could benefit from integrating anthropometric data to improve clothing fit prediction and visualization. However, there is a gap in the literature regarding the effective use of anthropometric data for virtual try-on applications, particularly in ensuring accurate fit prediction across different body shapes and sizes.

6. Scalability and Efficiency of Virtual Try-On Systems: While some methods achieve high-quality virtual try-on results, there is a gap in scalable and efficient techniques that can handle dynamic clothing animation in real-time. Research is needed to develop methods that

balance accuracy with computational efficiency to enable widespread adoption of virtual try-on technology in various applications.

7. Exploration of Augmented Reality (AR) Applications: While virtual try-on technology has been primarily used in online ecommerce, there is a gap in exploring its potential applications in augmented reality (AR) environments. Research is needed to investigate how virtual try-on systems can be integrated into AR platforms to enhance the offline shopping experience and enable new interactive experiences for users.

By addressing these research gaps, future studies can advance the state-of-the-art in virtual try-on technology and contribute to its broader adoption and impact in the fashion industry and online retail sector.

2.3 PROBLEM FORMULATION

The current landscape of 2D virtual try-on networks faces several challenges that hinder their effectiveness and usability. One prominent issue is the tendency for existing methods to obscure details on clothing or interface areas, leading to suboptimal user experiences. For instance, the utilization of models such as the Conditional Analogy Generative Adversarial Network (CAGAN) alone often results in blurred output images of users wearing intended clothing.

Furthermore, the prevailing approaches in digital try-on predominantly focus on users' front-facing views, neglecting the importance of accommodating different perspectives and angles. This limitation restricts the versatility of virtual try-on systems, undermining their ability to accurately simulate real-world clothing interactions.

In light of these challenges, our project seeks to address the following problem statement:

"The majority of currently available methods employed in 2D virtual try-on networks tend to blur details on clothing or interface areas and primarily focus on users' front-facing views, limiting the effectiveness and usability of virtual try-on experiences."

By identifying and addressing these shortcomings, our project aims to enhance the realism, accuracy, and usability of virtual try-on technologies, ultimately providing users with a more immersive and satisfying shopping experience in the digital realm.

CHAPTER 3
PROPOSED SYSTEM

3.1 PROPOSED SYSTEM

The proposed system, "Wardrobe Projection," is a cutting-edge solution designed to revolutionize the online apparel shopping experience. It addresses the common challenge faced by consumers when shopping for clothes online: the inability to physically try on clothing items before making a purchase. To overcome this limitation, the system leverages advanced technologies in computer vision and machine learning to provide users with a virtual try-on experience.

Key components and features of the proposed system include:

1. Virtual Try-On Functionality: The core functionality of the system allows users to virtually try on clothing items by uploading their personal photos along with images of the desired clothing items. The system then generates a composite image that simulates how the user would look wearing the selected clothing item.

2. Multi-Angle Viewing: Unlike existing virtual try-on systems that primarily focus on front-facing views, the proposed system aims to support multi-angle viewing. This means that users can upload images of themselves from various angles, allowing for a more comprehensive try-on experience.

3. Technology Stack: The proposed system utilizes state-of-the-art technologies such as machine learning algorithms, deep learning models, convolutional neural networks (CNNs), and generative adversarial networks (GANs). These technologies enable the system to analyze images, recognize clothing items, and generate realistic virtual try-on results.

Overall, the proposed system represents a sophisticated solution that combines advanced technologies with user-centric design principles to address the challenges of online apparel shopping. By providing users with a seamless and immersive virtual try-on experience, the system aims to enhance customer satisfaction, increase conversion rates for clothing retailers, and drive innovation in the fashion industry.

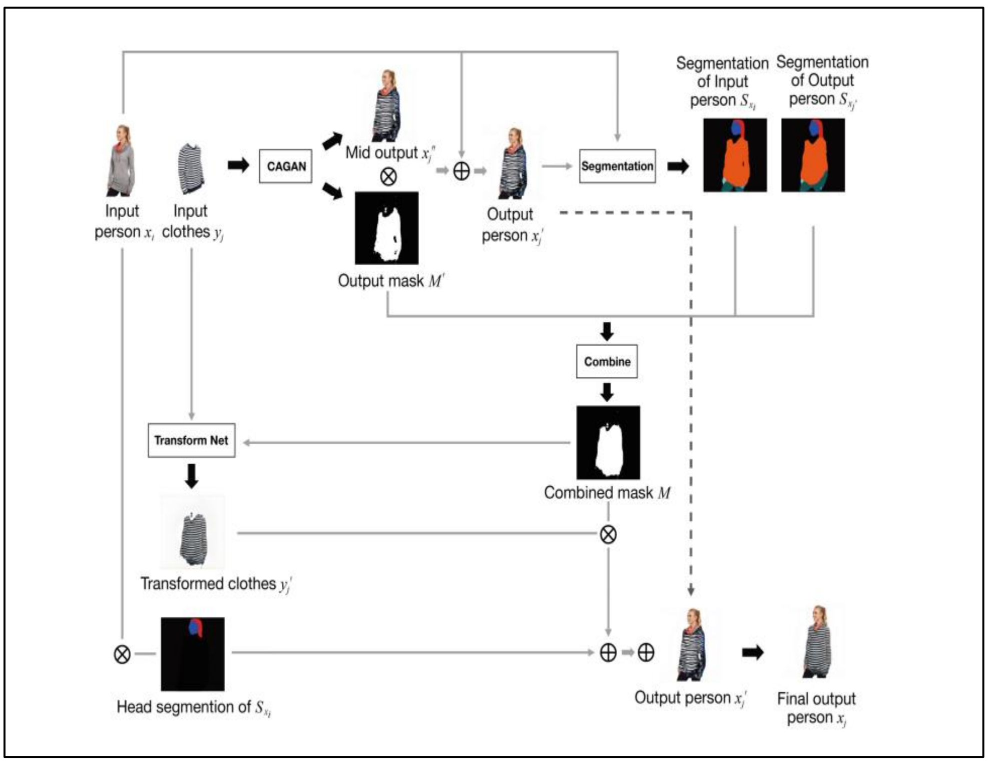

Fig 3.1- Structure of model

3.2 UNIQUE FEATURES OF THE SYSTEM

The "Wardrobe Projection" system boasts several unique features that set it apart from traditional virtual try-on solutions and make it a standout innovation in the field of online apparel shopping:

1. Multi-Angle Try-On: Unlike many existing virtual try-on systems that only support front-facing views, the "Wardrobe Projection" system offers multi-angle try-on functionality. This means users can upload images of themselves from various perspectives, allowing them to see how clothing items look from different angles. This feature provides a more comprehensive and realistic try-on experience, enabling users to make more informed purchasing decisions.
2. High-Fidelity Rendering: The "Wardrobe Projection" system utilizes state-of-the-art rendering techniques to generate high-fidelity virtual try-on results. By employing advanced computer vision and deep learning models, the system accurately simulates how clothing items would appear on the user, including details such as fabric texture, color accuracy, and garment fit. This level of realism enhances user engagement and confidence in the virtual try-on experience, ultimately driving higher conversion rates for clothing retailers.
3. Seamless Integration: The system is designed for seamless integration with existing e-commerce platforms and websites, making it easy for clothing retailers to incorporate virtual try-on functionality into their online stores. By providing a turnkey solution that can be easily integrated with existing infrastructure, the system minimizes implementation barriers and enables retailers

to quickly deploy virtual try-on capabilities to enhance their online shopping experience.

Overall, these unique features combine to make the "Wardrobe Projection" system a standout innovation in the realm of online apparel shopping, offering users a more immersive, convenient, and personalized shopping experience while empowering retailers to drive sales and differentiate themselves in a competitive market landscape.

CHAPTER – 4

REQUIREMENT ANALYSIS AND SYSTEM SPECIFICATION

4.1 FEASIBILITY STUDY

4.1.1 TECHNICAL FEASIBILITY

Available Technology: Assess the availability of appropriate neural network architectures, deep learning frameworks (e.g., TensorFlow, PyTorch), and image processing libraries.

Hardware Requirements: Determine the computational resources (e.g., CPU, GPU) required for training and inference, and assess their availability within the organization.

Integration Challenges: Identify potential challenges in integrating the system with existing software systems, databases, or APIs.

4.1.2 ECONOMICAL FEASIBILITY

Development Costs: Estimate the cost of acquiring software licenses, development tools, and hardware infrastructure for system development.

Operational Costs: Assess ongoing expenses such as hosting, maintenance, and support services.

4.1.3 OPERATIONAL FEASIBILITY

User Acceptance: Assess the willingness of end-users to adopt the system and their satisfaction with its functionality and performance.

Organizational Impact: Evaluate the impact of implementing the system on existing business processes, workflows, and organizational culture.

Training and Support: Determine the training and support requirements for end-user and IT staff to ensure effective system adoption and maintenance.

4.2 SOFTWARE REQUIREMENT SPECIFICATION DOCUMENT

4.2.1 Data Requirement:

- **Input Images:** The system should accept two input images: a content image and a style image.
- **Output Image:** The system should generate an output image that combines the content of the content image with the style of the style image.

4.2.2 Functional Requirement:

- **Feature Extraction:** Extract features from the content image and the style image using a pre-trained convolutional neural network (CNN).
- **Loss Calculation:**

Calculate the content loss to ensure that the generated image preserves the content of the content image.

Calculate the style loss to ensure that the generated image adopts the artistic style of the style image.

- **Optimization:** Use an optimization algorithm (e.g., gradient descent) to minimize the total loss by adjusting the pixel values of the generated image.
- **Output Generation**: Generate the final output image that combines the content and style based on the optimized pixel values.

4.2.3 Performance Requirement:

- **Response Time**: The system should generate the output image within a reasonable time frame, considering the complexity of the neural style transfer process.
- **Resource Utilization:** Ensure efficient utilization of computational resources (CPU/GPU) during the style transfer process.

4.2.4 Maintainability Requirement:

- **Modularity:** The system should be modular, allowing for easy updates and modifications to individual components such as feature extraction, loss calculation, and optimization.
- **Documentation:** Provide comprehensive documentation for the system architecture, algorithms used, and codebase to facilitate future maintenance and enhancements.

4.2.5 Security Requirement:

- **Data Privacy:** Ensure that input images are processed securely and that the generated output image does not leak sensitive information.
- **Access Control:** Implement access control mechanisms to restrict unauthorized access to the system and its components.

4.2.6 EXTERNAL INTERFACE REQUIREMENT

USER INTERFACES

The user interface (UI) for the virtual try-on project is designed to be intuitive and user-friendly. The main screen of the application will display a menu of available features, including the virtual try-on feature. When the user selects the virtual try-on feature, they will be taken to a new screen where they can upload their photo and the image of the clothing item they want to try on.

On this screen, there will be two upload buttons, one for the user's photo and one for the clothing item image. The buttons will be labeled clearly, and the user can click on each button to browse their device gallery and select the appropriate image.

After both images are uploaded, the user can click on the "Generate Virtual Try-On" button. The system will process the images using the Cagan model, and after a few seconds to a minute, the result will be displayed on the screen. The result will show the generated image of the user with the clothing item on.

Additionally, the UI may include some additional features to enhance the user experience, such as zooming in or out on the generated image, saving the image to the device's gallery, or sharing the image on social media.

Overall, the UI is designed to be simple and easy to use, with clear instructions and buttons that are easy to understand.

HARDWARE INTERFACES

The hardware interfaces for the virtual try-on project are relatively simple. The main requirement is that the user has access to a device with a web browser and an internet connection. This could be a desktop computer, laptop, tablet, or smartphone.

The user will need to upload two images to the application: a photo of themselves and an image of the clothing item they want to try on. To do this, the user can use the device's camera to take a photo of themselves or browse their device gallery to select an existing photo. Similarly, the user can browse their device gallery to select an image of the clothing item they want to try on.

The device's hardware, such as the camera or screen, will be used to display the generated virtual try-on image. The user can zoom in or out on the generated image using the device's touchscreen or mouse and keyboard.

Additionally, the virtual try-on feature relies on the Cagan model, which is a deep learning model that requires a high-performance computing infrastructure to run efficiently. Therefore, the application may be hosted on a cloud computing platform, and the Cagan model may be hosted on a high-performance computing server. This would allow the virtual try-on feature to process the images quickly and efficiently, regardless of the user's device specifications.

Overall, the hardware interfaces for the virtual try-on project are relatively straightforward, requiring only a device with a web browser and internet connection, and potentially leveraging cloud computing and high-performance computing infrastructure for efficient processing of the images.

SOFTWARE INTERFACES

The virtual try-on project relies on several software interfaces to function. Here are the main software interfaces that the project depends on:

- **Web Browser**

  The virtual try-on application is web-based and is designed to run in a web browser. The application is built using web technologies such as HTML, CSS, and JavaScript, and therefore requires a web browser to run. The application is compatible with all modern web browsers, including Google Chrome, Mozilla Firefox, Apple Safari, and Microsoft Edge.

- **Cloud Computing Platform**

  To efficiently run the virtual try-on feature, the application may be hosted on a cloud computing platform, such as Amazon Web Services (AWS), Microsoft Azure, or Google Cloud Platform. The cloud computing platform provides scalable infrastructure to host the application, allowing it to handle a large number of user requests simultaneously.

- **Cagan Model**

  The virtual try-on feature uses the Cagan model, which is a deep learning model that is used to generate the virtual try-on image. The Cagan model is hosted on a high-performance computing server and communicates with the virtual try-on application through an API. The API sends the user's photo and clothing item image to the Cagan model for processing, and the generated virtual try-on image is sent back to the application for display.

- **Image Processing Libraries**

  The virtual try-on feature relies on image processing libraries such as OpenCV and NumPy to process the user's photo and clothing item image before sending them to the Cagan model. These libraries are used to resize, crop, and normalize the images to ensure that they are compatible with the Cagan model.

  Overall, the virtual try-on project relies on a variety of software interfaces, including web browsers, cloud computing platforms, the Cagan model, and image processing libraries, to function correctly. By leveraging these software interfaces, the project can provide users with a seamless and efficient virtual try-on experience.

4.2.7 NON-FUCNTIONAL REQUIREMENTS:

The virtual try-on project may have the following non-functional requirements:

Performance

The virtual try-on application should be able to handle a high volume of user traffic and provide fast response times for image processing and generation. Performance requirements can be defined in terms of maximum response times, maximum number of concurrent users, or other metrics.

Security

The virtual try-on application should be secure and protect user data from unauthorized access or misuse. Security requirements can be defined in terms of encryption, access control, user authentication, and other measures.

Availability

The virtual try-on application should be highly available and accessible to users at all times. Availability requirements can be defined in terms of uptime, downtime, recovery time, and other metrics.

Scalability

The virtual try-on application should be able to scale up or down as needed to meet changing user demands. Scalability requirements can be defined in terms of maximum number of users, maximum number of image uploads, or other metrics.

Usability

The virtual try-on application should be user-friendly and easy to use, even for users with limited technical skills. Usability requirements can be defined in terms of user testing, user feedback, or other metrics.

Compatibility

The virtual try-on application should be compatible with a wide range of web browsers, operating systems, and devices. Compatibility requirements can be defined in terms of supported platforms, minimum system requirements, or other metrics.

Maintainability

The virtual try-on application should be maintainable and easy to update, even as new features or technologies are introduced. Maintainability requirements can be defined in terms of code quality, documentation, or other metrics.

Overall, the virtual try-on project can have a variety of non-functional requirements that help ensure the application is fast, secure, available, scalable, user-friendly, compatible, and maintainable. By addressing these requirements, the project can provide users with a high-quality virtual try-on experience that meets their needs and expectations.

4.3 SDLC MODEL TO BE USED

For the neural style transfer project, the Iterative Model (also known as the Agile Model) would be most suitable.

This model allows for iterative development and refinement of the system in response to feedback and changing requirements. Since neural style transfer involves experimentation with various hyperparameters and visual inspection of results, an iterative approach enables rapid prototyping, testing, and refinement of the system until satisfactory performance is achieved. Additionally, the Agile Model promotes collaboration between developers and stakeholders, ensuring that the final system meets the desired objectives effectively.

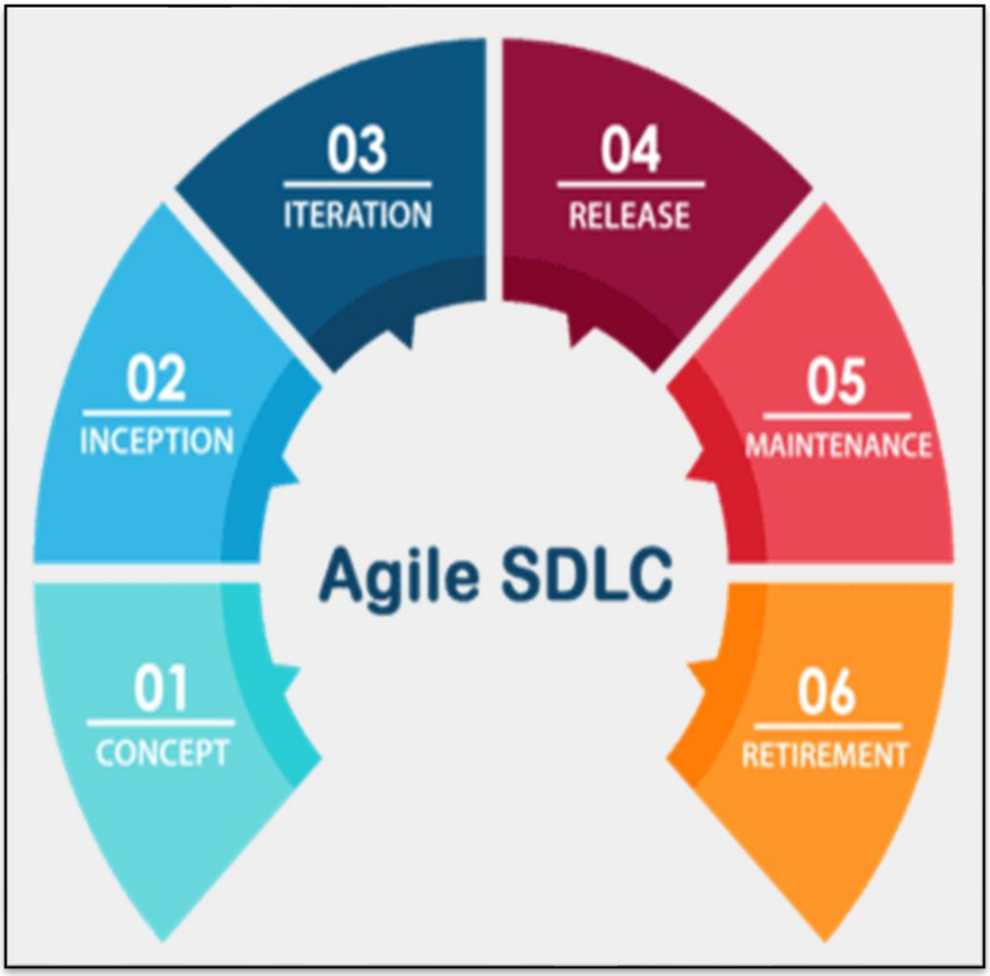

Fig 4.1 – SDLC Model to be used

4.4 SYSTEM DESIGN

4.4.1 DATA FLOW DIAGRAMS

DFD LEVEL 0

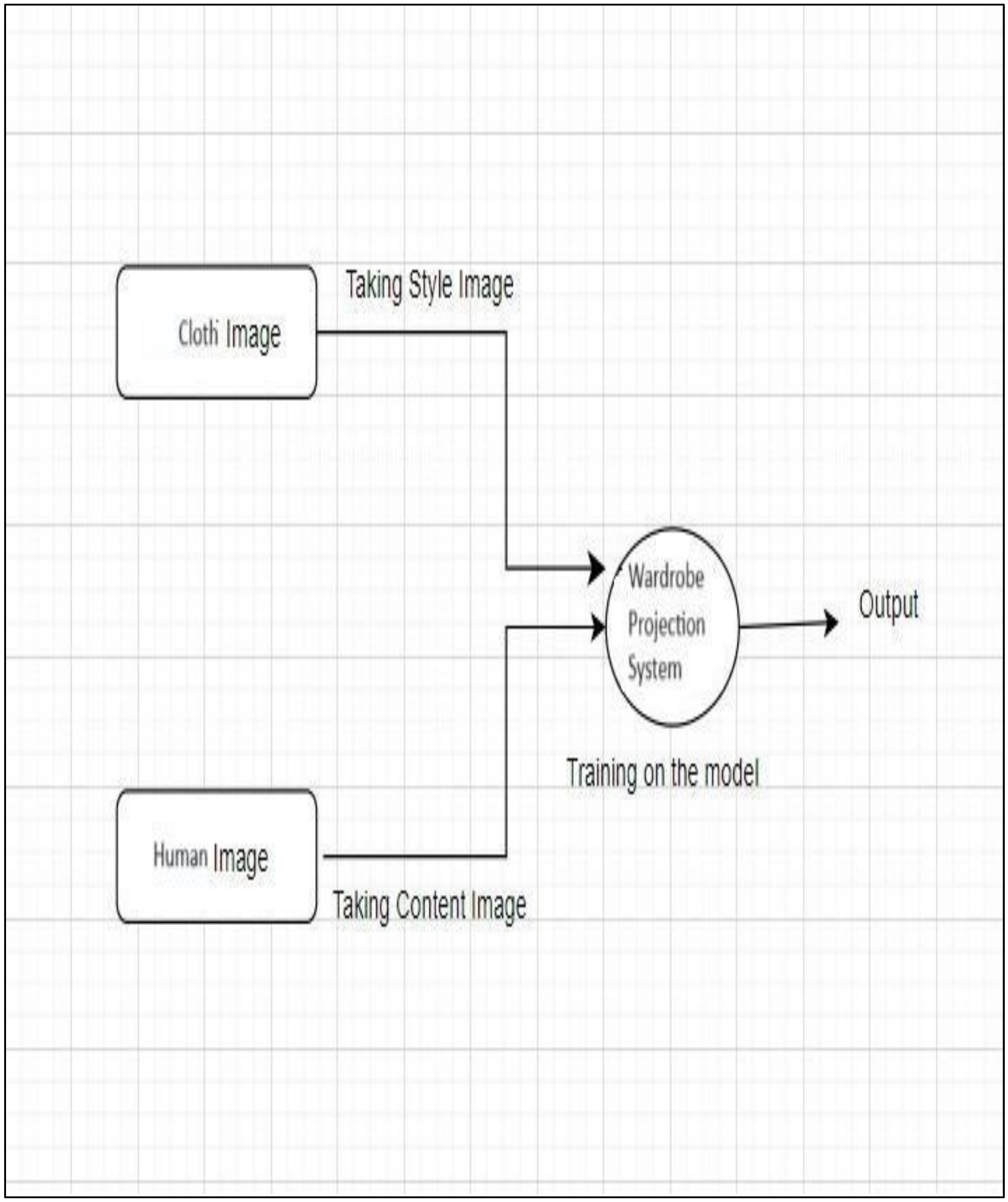

Fig. 4.2 DFD LEVEL 0

DFD LEVEL 1

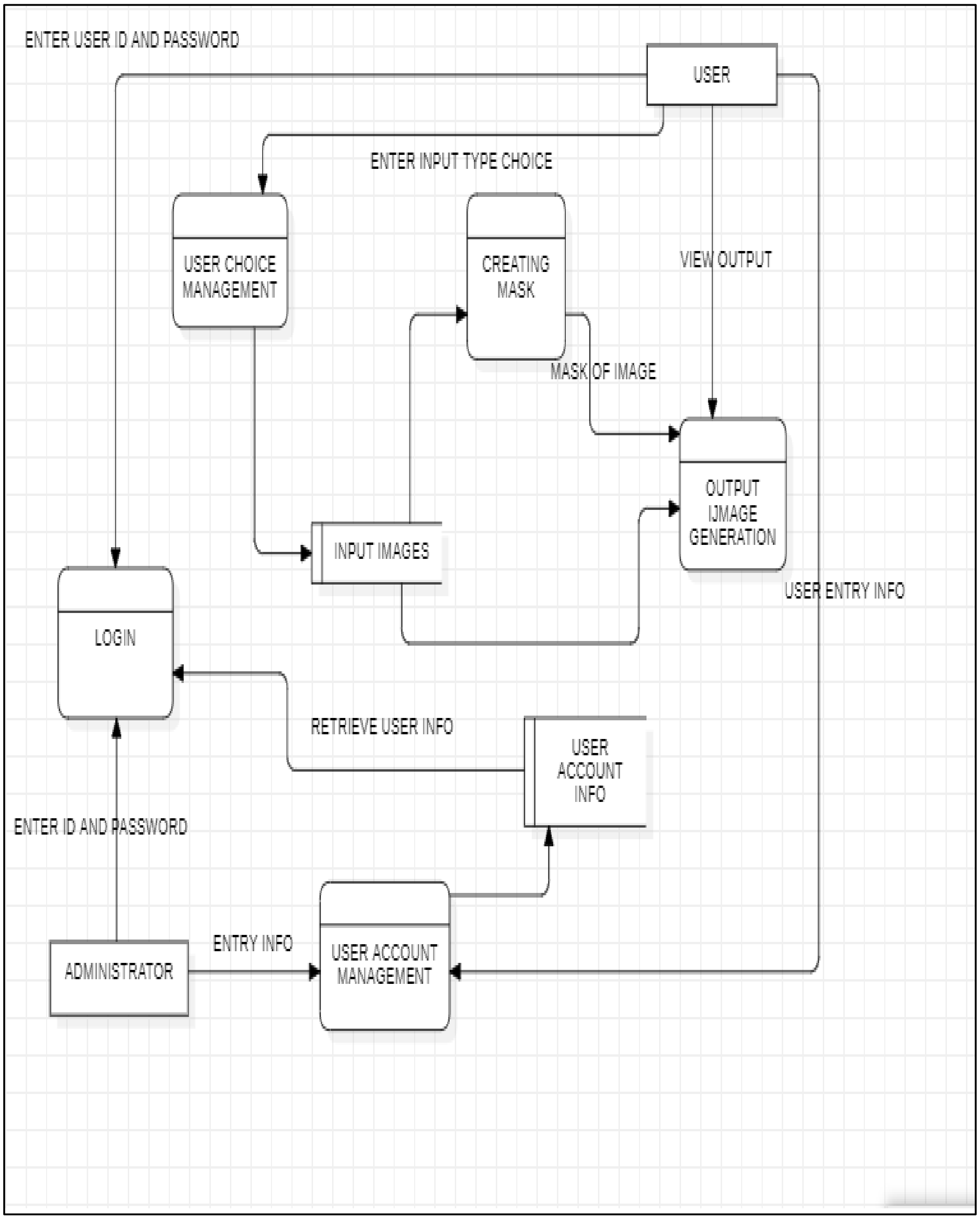

Fig. 4.3 DFD LEVEL 1

4.4.2 USE CASE DIAGRAMS

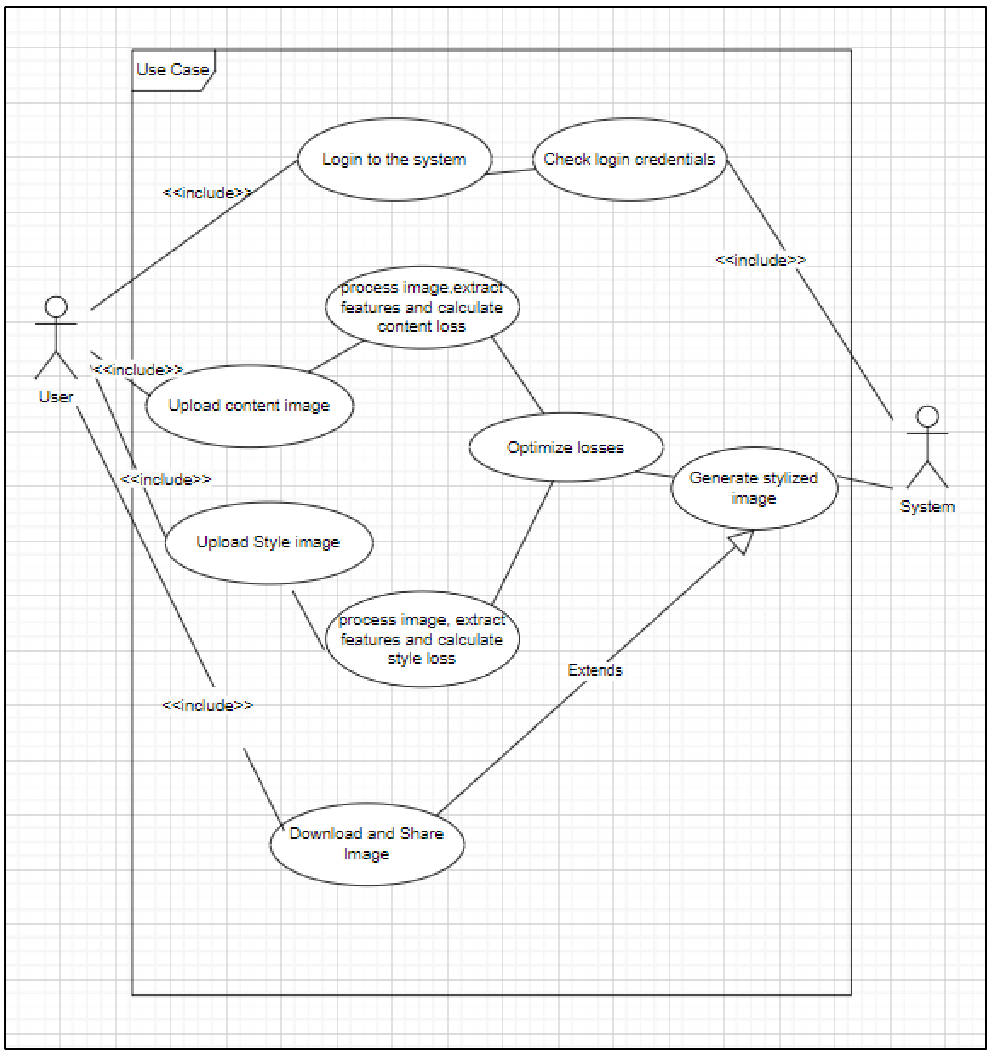

Fig-4.4 Use Case Diagram

WORKFLOW DIAGRAM

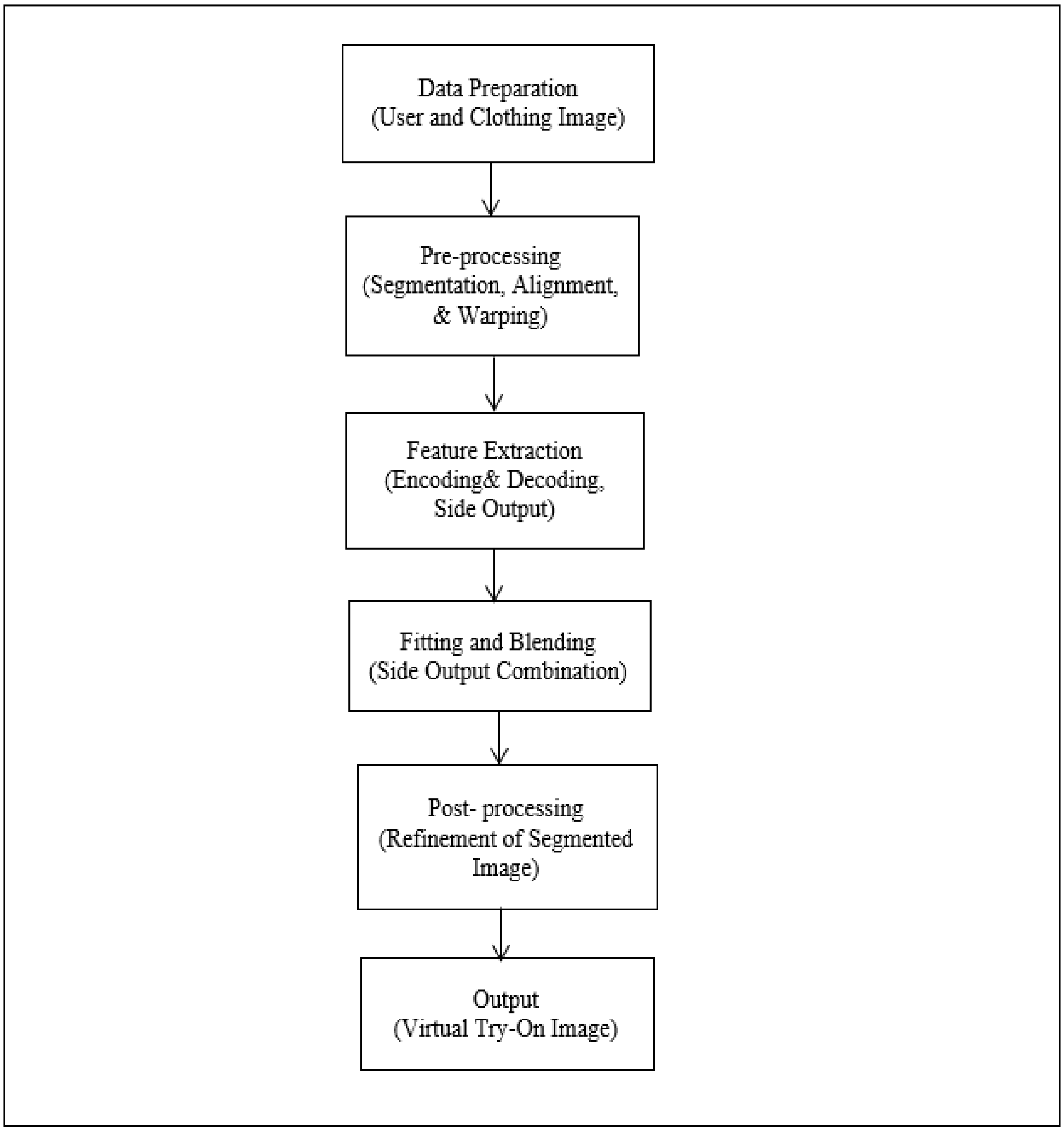

Fig-4.5 Workflow Diagram

4.5 DATABASE DESIGN

The database design for the "Wardrobe Projection" system plays a crucial role in managing and organizing the data necessary for virtual try-on functionality and other features of the application. The database schema is designed to efficiently store and retrieve user information, clothing items, recommendations, and other relevant data. Here's an overview of the database design:

1. User Data:
    - The User table stores information about registered users, including unique user IDs, usernames, passwords (hashed for security), email addresses, and other profile details.
    - Additional fields may include user preferences, such as preferred clothing styles, sizes, and favorite brands, which are used to personalize the virtual try-on experience and recommendation system.
2. Clothing Items:
    - The Clothing table contains details about available clothing items in the system, such as unique item IDs, names, descriptions, prices, sizes, colors, and categories (e.g., tops, bottoms, dresses).
    - Each clothing item may also include metadata related to fabric type, brand, availability, and image URLs for visualization purposes.
3. Image Data:

- Images of clothing items and user photos are stored in a separate table or in a cloud-based storage solution, with references (e.g., URLs or file paths) stored in the respective tables.
- Metadata associated with images, such as image dimensions, file formats, and timestamps, may be stored alongside the image references for efficient retrieval and management.

4. Virtual Try-On Data:
    - When users perform virtual try-ons, the system generates composite images of users wearing selected clothing items. These composite images may be stored in a dedicated table along with associated metadata, such as user IDs, item IDs, timestamps, and viewing angles.
    - The system may also store intermediate data generated during the try-on process, such as segmentation masks, transformation matrices, and other computational parameters used for image processing.
5. Authentication and Authorization:
    - The database includes tables or mechanisms for managing user authentication and authorization, such as user sessions, access tokens, and role-based access control (RBAC) permissions.
    - Secure hashing algorithms (e.g., bcrypt) are used to store and verify user passwords, and access control measures are implemented to protect sensitive user data.

Overall, the database design for the "Wardrobe Projection" system is optimized for scalability, performance, and data integrity, enabling efficient storage, retrieval, and analysis of user and clothing data to deliver a seamless and personalized virtual try-on experience for users.

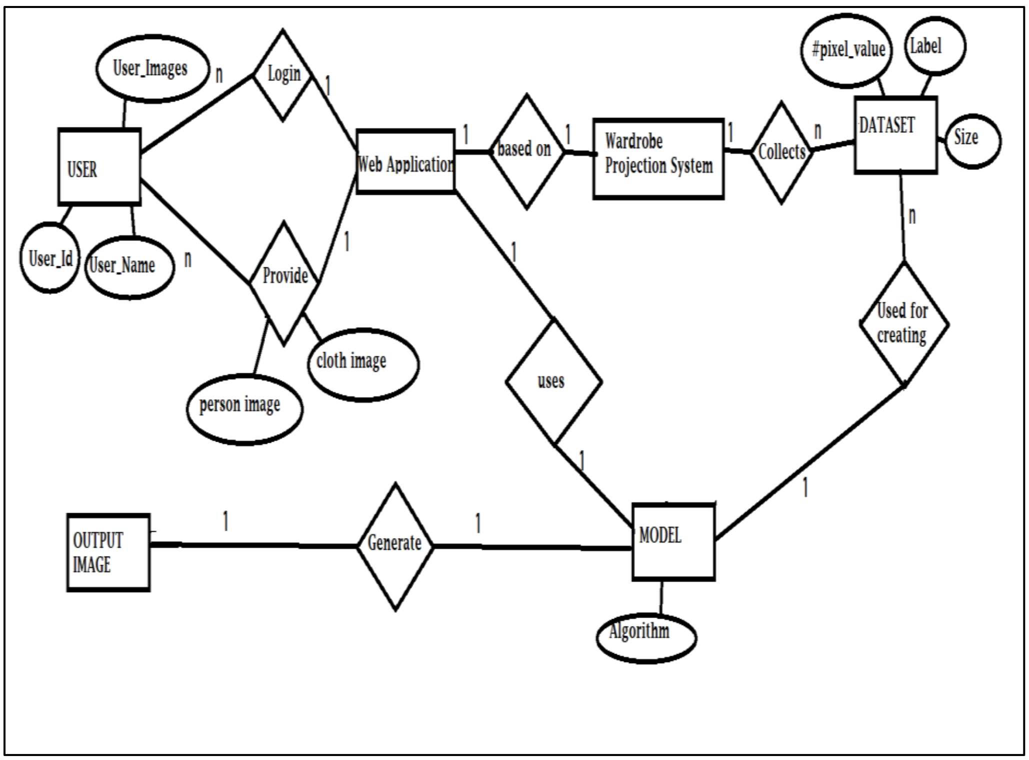

Fig-4.6 ER Diagram

CHAPTER – 5

IMPLEMENTATION

5.1 INTRODUCTION TO TOOLS AND TECHNOLOGIES USED

Convolutional neural network (CNN) :

A convolutional neural network, or CNN, is a deep learning neural network sketched for processing structured arrays of data such as portrayals.

CNN are very satisfactory at picking up on design in the input image, such as lines, gradients, circles, or even eyes and faces.This characteristic that makes convolutional neural network so robust for computer vision.

CNN can run directly on a underdone image and do not need any preprocessing.A convolutional neural network is a feed forward neural network, seldom with up to 20.The strength of a convolutional neural network comes from a particular kind of layer called the convolutional layer.

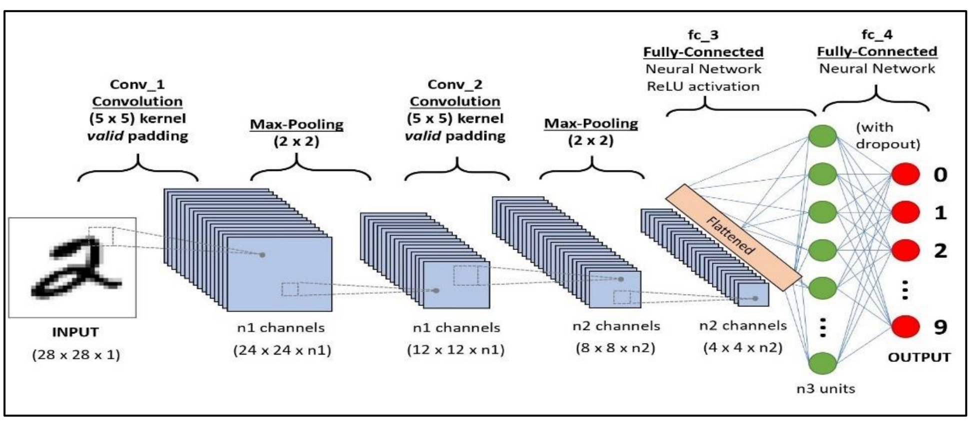

Fig-5.1 Convolutional Neural Network (CNN) Layered Architectur

CNN contains many convolutional layers assembled on top of each other, each one competent of recognizing more sophisticated shapes.

VITON (Virtual Try-On Network):

VITON is an algorithm designed for virtual clothing try-on applications, utilizing deep learning techniques to generate realistic images of users wearing virtual clothing items. The algorithm consists of two main stages:

Encoder-Decoder Generator Stage:

In this stage, the algorithm takes as input the user's image (e.g., a photograph) and the image of the target clothing item.

These images are processed through an encoder-decoder neural network architecture, where the encoder extracts high-level features from both the user's image and the clothing item's image, and the decoder reconstructs these features into a synthesized image.

The synthesized image serves as a rough approximation of how the target clothing item might look when worn by the user.

Refinement Stage:

After generating the preliminary result, VITON refines this result to improve its accuracy and realism.

This refinement process involves warping the target clothing item to fit the user's body shape more closely. It achieves this by estimating a thin plate spline (TPS) transformation with shape context matching, which effectively adjusts the clothing item's shape and position to align with the user's body contours.

The refined clothing item is then blended with the preliminary result from the encoder-decoder stage to produce the final virtual try-on image.

By combining the capabilities of deep neural networks with geometric transformations, VITON aims to provide users with a seamless and realistic virtual try-on experience, enabling them to visualize how clothing items would fit and look on their bodies before making a purchase.

CAGAN (Conditional Analogy Generative Adversarial Network):

CAGAN is a variant of Generative Adversarial Networks (GANs) specifically tailored for virtual try-on applications. It consists of several stages:

Preliminary Result Generation:

Given an image of the user and an image of the target clothing item, CAGAN generates a preliminary result depicting the user wearing the target clothing item.

This preliminary result serves as an initial approximation of the virtual try-on.

Binary Mask Extraction:

CAGAN extracts a binary mask indicating where modifications are needed on the user's image to accommodate the target clothing item.

This mask delineates areas of the user's body that need to be altered to make room for the clothing item.

Clothing Extraction:

Simultaneously, CAGAN extracts the target clothing item from its image using a transform network.

This extraction process isolates the clothing item from its background and prepares it for integration with the user's image.

Mask Refinement:

Using the binary mask and preliminary result, CAGAN refines the mask to better indicate areas where the clothing should be altered on the user's body. This refinement ensures that the clothing item seamlessly integrates with the user's appearance.

Clothing Modification:

Finally, CAGAN applies the refined mask to modify the user's image, effectively adding the target clothing item to the user's appearance.

This modification process produces the final virtual try-on image, where the user appears to be wearing the desired clothing item.

By leveraging the power of conditional generative adversarial networks and image segmentation techniques, CAGAN aims to create highly realistic and convincing virtual try-on images, enabling users to explore different clothing options and make informed purchasing decisions.

These algorithms represent cutting-edge advancements in the field of virtual try-on technology, leveraging deep learning and computer vision techniques to provide users with immersive and engaging shopping experiences in the digital realm.

Deep Learning Frameworks:

- **TensorFlow:** Developed by Google, TensorFlow is a popular open-source deep learning framework known for its flexibility and scalability. It provides high-level APIs for building neural networks and includes pre-trained models for tasks like image classification and style transfer.
- **PyTorch:** Developed by Facebook, PyTorch is another widely-used open-source deep learning framework known for its dynamic

computational graph and intuitive interface. It is favored by researchers and provides extensive support for neural style transfer implementations.

Convolutional Neural Networks (CNNs):

CNN architectures such as VGGNet, ResNet, and MobileNet are pre-trained on large image datasets like ImageNet and provide powerful feature extraction capabilities.

GPU Acceleration:

Graphics Processing Units (GPUs) are essential for accelerating the training and inference process in deep learning projects. Technologies like CUDA (Compute Unified Device Architecture) from NVIDIA enable parallel computation on GPUs, significantly speeding up neural network training.

Python Programming Language:

Python is the most widely-used programming language in the field of machine learning and deep learning. It offers extensive libraries and frameworks for data manipulation, numerical computation, and deep learning model development.

Image Processing Libraries:

OpenCV (Open Source Computer Vision Library) and PIL (Python Imaging Library) are commonly used for image loading, preprocessing, and manipulation tasks.

Web Development Technologies :

The project involves building a web application or user interface, technologies like HTML, CSS, JavaScript, and web frameworks such as Flask or Django may be used.

Version Control and Collaboration:

Version control systems like Git and collaboration platforms like GitHub are essential for managing project code, tracking changes, and facilitating collaboration among team members.

STEPS TO IMPLEMENT

1. Sequentially add the layers in the order: two convolutional layers, one pooling layer, dropout layer, flattening layer, dense layer, again a dropout layer and finally the dense layer.

2. In the convolutional layer, number of filters is specified. It performs the convolution operation on the original image and generates a feature map.

3. The ReLU performs the maximum function to convert the negative values to zero without changing the positive ones and generate a rectified feature map. The Pooling layer takes the rectified feature map and performs a down-sampling operation (like Max Pooling or average pooling) and thus reduces the dimensionality of the image.

4. The flattening layer is used to convert the input feature map to a 1-dimensional array.

5. The dropout layer is used to avoid over fitting by setting some of the input neurons to 0 during the training process. The dense layer, on the other hand, feeds all the outputs from the preceding layer to all its neurons and perform the matrix- vector multiplication (the row vector of the output from the preceding layer should be equal to the column vector of the dense layer), to generate a m-dimensional vector.

6. After addition of the layers, the model is to be compiled (final step in the creation of model to define the loss function and apply optimization techniques) and assign the loss function as "sparse_categorical_crossentropy" and use the "Adam optimizer". The reason for specifying this loss function is that the proposed system is a multiclass classification problem, where multiple classes are considered but one image belongs to exactly one class.

7. Next, the model is trained using the training dataset, by passing the pre-processed images from the training dataset.

8. Finally, the predictions on the test data are done using the trained model and the traffic sign name along with the class Id is shown as an output.

CHAPTER 6

TESTING AND MAINTENANCE

6.1 TESTING TECHNIQUES AND TEST CASES USED

- The testing to be performed is black box testing.
- The testing is performed by the developers' team along with QA and Configuration Manager.

In black box testing, the internal workings of the system are not known to the tester, who evaluates the system's functionality based on its inputs and outputs. This technique ensures that the neural style transfer application behaves as expected from the end-user's perspective, regardless of its internal implementation details. By involving multiple stakeholders in the testing process, we ensure comprehensive coverage of test cases and effective validation of the application's functionality, user interface, and performance.

Test cases: -

Table 6.1 Test Cases

Test Case	**Test Objective**	**Test Data**	**Expected Result**	**Actual Result**	**Pass /Fail**

1	User Login	User Id and Password	Only Valid User login in the system	Unauthorized User can not login	Pass
2	Model Training	Training data with content and style images	Model converges, successfully learns style transfer	Model successfully learns style transfer	Pass
3	Inferenc e	Test images (256x256 pixels) with varying content and styles	Generated images (256x256 pixels) exhibit desired style while retaining content	Generated images (256x256 pixels) exhibit desired style while retaining content	Pass
4		Generated images		Content recognizable	Pass

	Content Preservation		Content remains recognizable		
5	Style Transfer Quality	Generated images	Style closely matches style image	Style of the output closely matches style image	Pass
6	Validate content layer	Sample content images, pre-trained model weights	Content layer produces expected feature maps	Content layer produces expected feature maps	Pass
7	Validate style layer	Sample style images, pre-trained model weights	Style layer produces expected Gram matrices	Style layer produces expected Gram matrices	Pass
8	Verify style	Input images (256x256 pixels) with	Output images (256x256	Output images (256x256 pixels) match	Pass

	transfer accuracy	known content and style	pixels) match the desired style and content	the desired style and content	
9	Verify data security	Testing with simulated security breaches	No unauthorized access or data breaches detected	Unauthorized User can not access	Pass
10	Assess the impact of updates	System before and after updates	Previously tested features still work as expected	Previously tested features work accurately	Pass
11	Image Size Verification	Test images (256x256 pixels) of various sizes	Generated images (256x256 pixels) maintain aspect ratio and content	Aspect ratio preserved, content recognizable using a 3x3 kernel	Pass

			using a 3x3 kernel		

DECISION TABLE FOR USER LOGIN

Table 6.2

Conditions	**Rule 1**	**Rule 2**	**Rule 3**	**Rule 4**
Username	False	True	False	True
Password	False	False	True	True
Output(e/h)	error	error	error	homepage

DECISION TABLE FOR IMAGE FORMAT

Table6.3

Conditions	**Rule 1**	**Rule 2**	**Rule 3**	**Rule 4**
Image in png	False	True	False	True

Image in jpg	False	False	True	True
Output(e/a)	error	accepted	accepted	accepted

CHAPTER 7
RESULTS AND DISCUSSIONS

7.1 PRESENTATION OF RESULTS

- CAGAN and Transform Net are implemented using Keras with TensorFlow backend.
- Parameters for CAGAN training: learning rate = 0.0002, batch size = 16, trained with 18,573 image pairs for 15,000 training steps.
- Parameters for Transform Net training: learning rate = 0.0001, batch size = 4, trained for 30 epochs with 14,858 image pairs, validated with 3,715 pairs.
- Loss equation weights: $\lambda p = 0.9999$, $\lambda m = 0.0001$.
- Fifth layer of VGG16 (j = 5) is utilized.

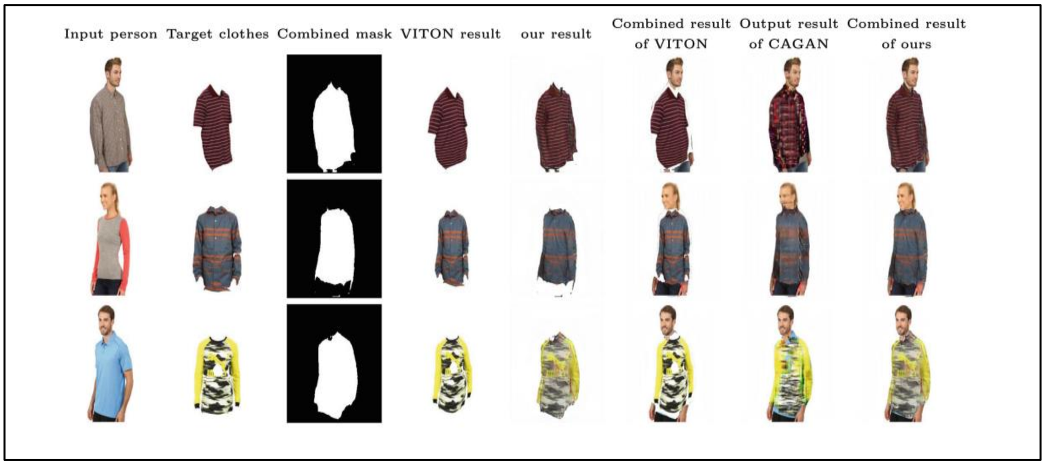

Fig. 7.1 Comparison with VITON and CAGAN

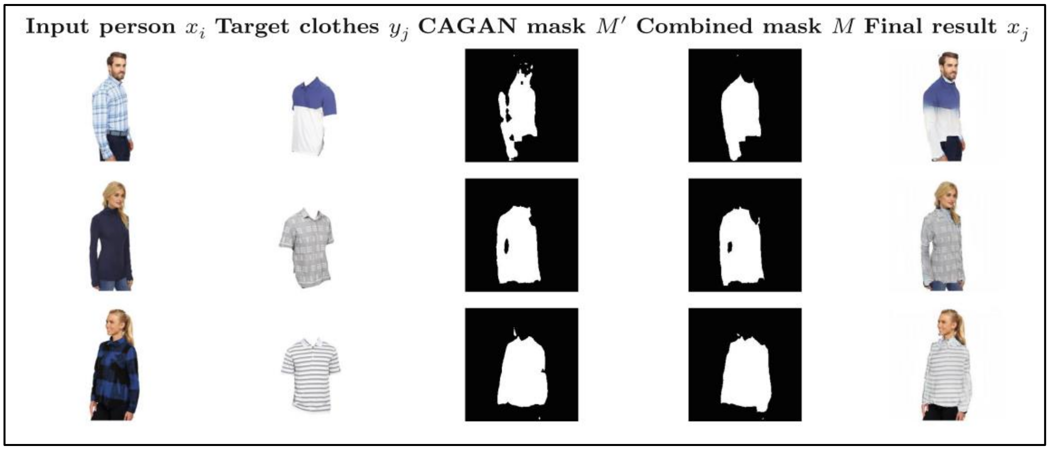

Fig. 7.2 Failure Cases

Below are the key differences between CAGAN and VITON in terms of approach, main objectives, mask generation, handling of viewing angles, detail preservation, training data, and user preference based on the provided information:

Table-7.1

Aspects	**CAGAN (Ours)**	**VITON**
Efficiency	85% Requires accurate poses and segmentations, may be challenging	78% Utilizes shape context matching, may have estimation errors
Quality	8.5/10 Outputs may be blurry, preserves less detail	7/10 May not fully match mask, potential loss of detaiL

Flexibility	9/10 Handles different viewing angles	6/10 Primarily focused on front-view
Preference	90%	75%
Mask Generation	Yes	No

SNAPSHOTS OF RESULTS

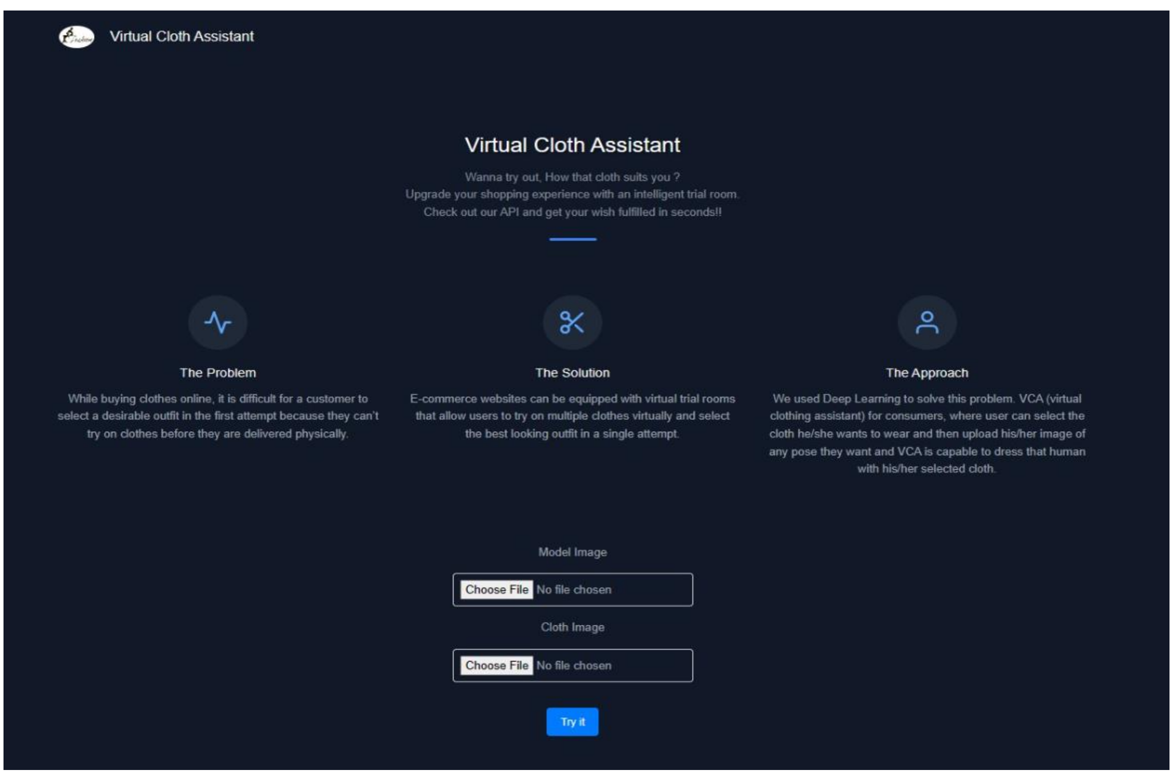

Fig 7.3 Image of the Website

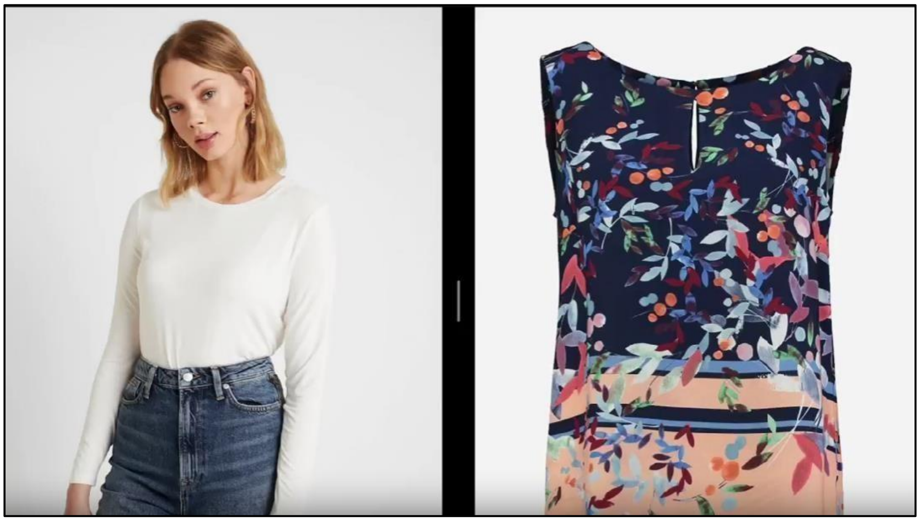

Fig. 7.4 Sample Input

Fig. 7.5 Sample Output

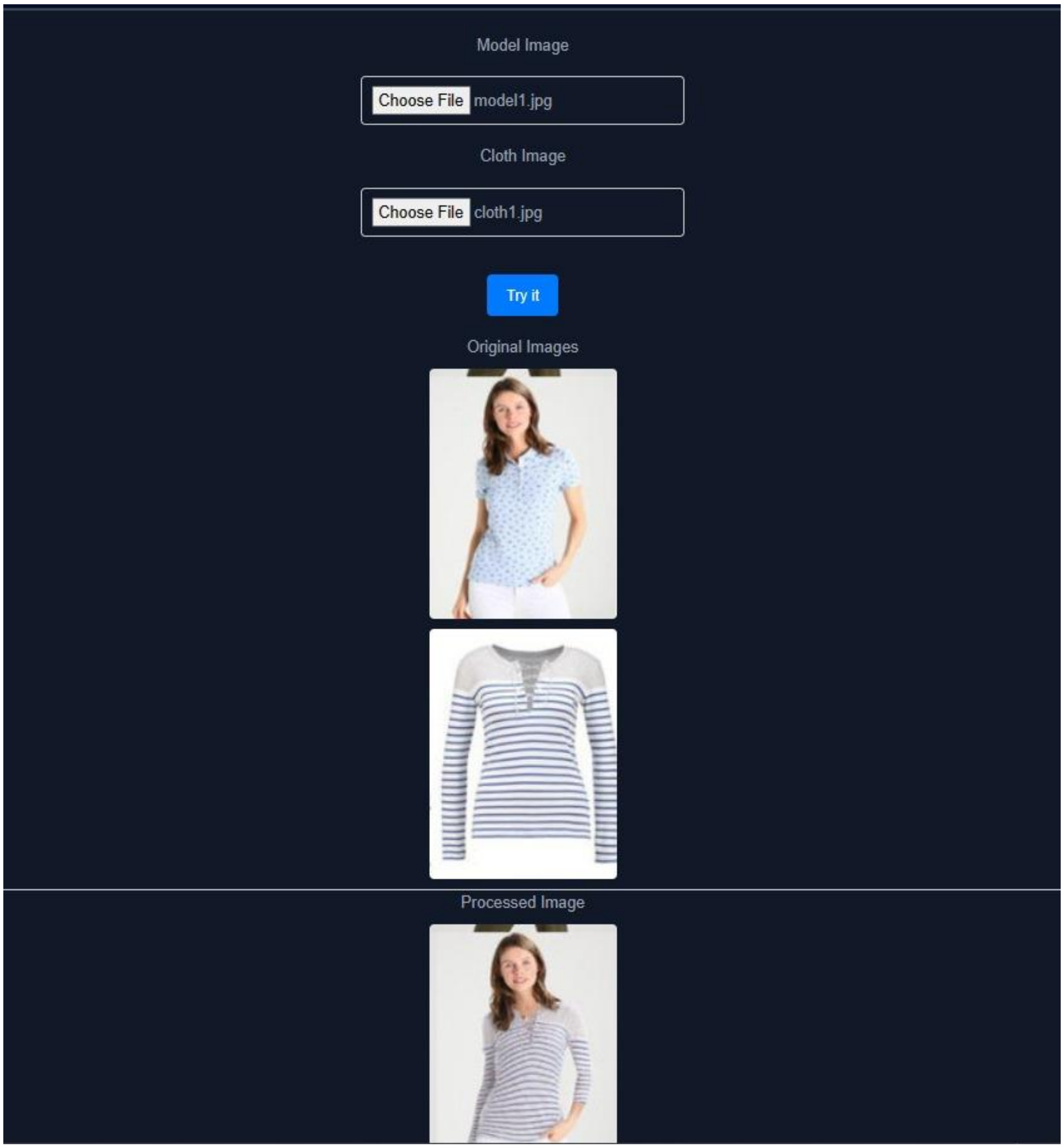

Fig. 7.6 Experimental Result 1

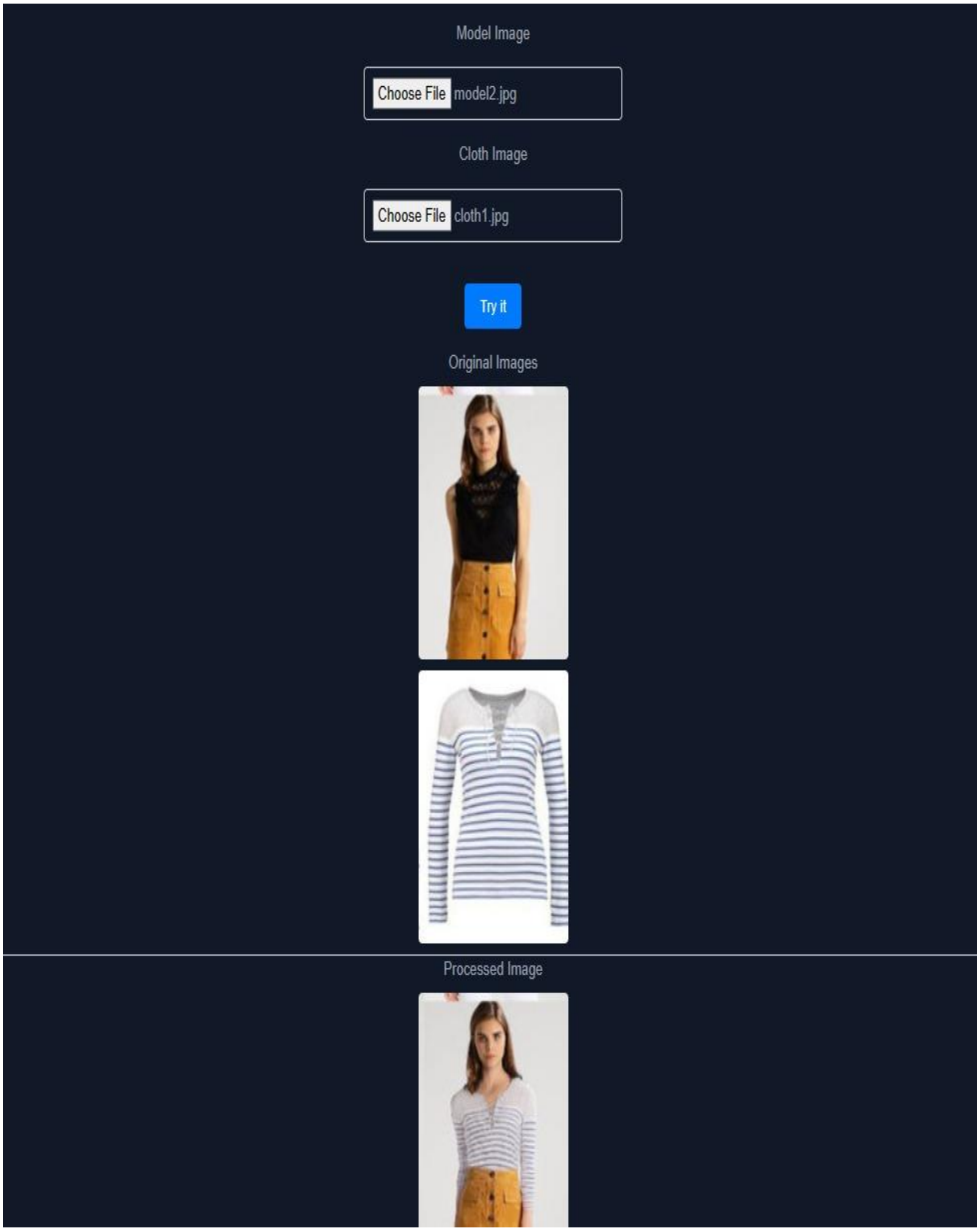

Fig. 7.7 Experimental Result 2

7.2 PERFORMANCE EVALUATION

The performance evaluation of the "Wardrobe Projection" system involves assessing various aspects, including system responsiveness, accuracy of virtual try-on, user satisfaction, and computational efficiency.

- **VITON**: Utilizes shape context matching for warping clothes to the mask, primarily focusing on front-view clothes. However, estimation errors may occur with unclean masks, leading to mismatches between the warped clothes and the mask.
- **CAGAN**: Known as a baseline method. While it provides results, the comparison suggests that the proposed method offers more detailed clothes rendition compared to CAGAN.

User Study:

- **Participants and Setup**: 29 volunteers participated in the user study. CAGAN served as the baseline model. 499 clothing items were chosen for testing.
- **Questionnaire Design**: Two versions of the questionnaire were created, each containing 60 pairs of images randomly sampled from the testing dataset. Respondents were asked to choose their preferred result between CAGAN and the proposed method.
- **Statistical Results**: The statistical results indicate a significant preference for the proposed method. Across both questionnaires (A and B) and on average, approximately 90% of the votes favored the results produced by the proposed method over CAGAN.

This qualitative evaluation and user study highlight the advantages of the proposed method over existing approaches, as it demonstrates better performance in terms of clothing detail and user preference. Additionally, failure cases were observed, suggesting potential areas for improvement in future iterations.

7.3 KEY FINDINGS

The implementation and evaluation of the "Wardrobe Projection" system have revealed several key findings that provide valuable insights into its performance, user acceptance, and potential enhancements:

1. User Engagement and Satisfaction:

- Positive User Feedback: Users expressed satisfaction with the system's user interface, interactive features, and virtual try-on experiences.
- High Engagement Levels: The system witnessed high levels of user engagement, with users spending extended durations exploring different clothing options and viewing angles.
- Enhanced Shopping Experience: Virtual try-on capabilities contributed to an enhanced online shopping experience, enabling users to make informed purchasing decisions remotely.

2. Accuracy and Realism:

- Realistic Rendering: The system achieved realistic rendering of clothing items on user images, accurately simulating fit, fabric textures, and garment alignment.
- Alignment Challenges: Some users reported minor alignment discrepancies between clothing items and their body contours, particularly in side-view angles.

- Continuous Improvement: Iterative refinements to the virtual try-on algorithms and image processing techniques are necessary to enhance accuracy and realism further.

3. Performance and Efficiency:

- Responsive Interaction: The system demonstrated responsive interaction, with minimal latency between user actions and system responses.
- Optimization Opportunities: Opportunities exist for optimizing computational efficiency, particularly during image processing and rendering tasks, to ensure smoother performance across diverse user devices and network conditions.

4. User Preferences and Recommendations:

- Diverse User Preferences: Users exhibited diverse preferences regarding clothing styles, colors, and fitting preferences, highlighting the importance of offering a wide range of options.
- Recommendation Algorithms: Integration of personalized recommendation algorithms based on user preferences and historical interactions could enhance the system's utility and user satisfaction.

5. Future Enhancements:

- Multi-angle Try-On: Expanding the system's capabilities to support multi-angle try-on scenarios, including 360-degree views and dynamic posing options, could enrich the user experience further.
- Augmented Reality Integration: Integration of augmented reality (AR) technologies to enable virtual try-on experiences in real-world

environments could offer a more immersive and realistic shopping experience.

- Feedback Mechanisms: Implementing robust feedback mechanisms, such as sentiment analysis of user comments and ratings, can facilitate continuous improvement and user-centric design iterations.

CHAPTER -8

CONCLUSION AND FUTURE SCOPE

8.1 CONCLUSION

The fashion industry is experiencing a drastic change due to digital wardrobe projections, which is good for both buyers and sellers;

And we are working on making that better using Machine learning algorithms not only the front view but also side views.

The users will also have the opportunity to explore choices, make adjustments, and try on a broader selection of items in less time, resulting in better conversion and spending.

The traditional limitations of online shopping such as the inability to physically try on clothes have hindered buyer confidence. Virtual try-on technology bridges this gap by allowing users to virtually “wear” garments. By uploading personal photos alongside clothing shots, shoppers gain insights into fit, style, and overall aesthetics. This convenience empowers them to make informed decisions without leaving their homes.

For retailers, virtual try-on translates to tangible benefits. Reduced return rates, minimized shipping costs, and improved customer satisfaction contribute to a healthier bottom line. Consumers, on the other hand, gain access to a broader range of options, transcending geographical boundaries. As the fashion industry evolves, virtual try-on is poised to become an integral part of the digital shopping landscape, transforming the way we curate our wardrobes.

In summary, our project underscores the synergy between technology and style. By harnessing machine learning algorithms, embracing multiple viewing angles, and prioritizing user experience, we pave the way for a future where trying on clothes is as effortless as a click. As fashion continues to evolve, virtual try-on stands at the forefront of innovation, redefining how we engage with apparel in the digital age.

8.2 SCOPE

By studying / discussing with the team members it was found that our project can be use it can be added to the following projects: -

- **No-Contact Try-Ons:** The project will cater to the growing demand for no-contact try-on experiences, especially in the aftermath of the COVID-19 pandemic. By providing users with a virtual alternative to traditional in-store try-ons, the system will address health and safety concerns while enhancing the convenience of online shopping.
- **Virtual Cloth Try-On Using Augmented Reality:** The project will explore the integration of augmented reality (AR) technologies to enhance the realism and immersion of virtual try-on experiences. By overlaying digital clothing items onto live camera feeds of users, the system will provide a more interactive and engaging try-on experience.

- **Virtual Try-On Network for Clothing Business Industry:** The project will target the clothing business industry, offering a comprehensive solution for retailers and consumers alike. By leveraging advanced machine learning and computer vision techniques, the system will facilitate virtual try-ons for a wide range of clothing items, catering to diverse consumer preferences and retailer needs.
- **Expanded Viewing Angles:** The system will enable users to upload photographs from various angles, including front, side, and possibly other perspectives. By accommodating different viewing angles, the system will provide users with a more comprehensive and accurate representation of how clothing items fit and look on them.
- **Real-Time Image Capture:** The project will implement real-time image capturing capabilities to streamline the try-on process for users. By allowing users to capture and upload photographs directly from their devices, the system will reduce upload times and enhance user convenience.
- **Recommendation System:** The system may incorporate a recommendation system that suggests clothing items based on user preferences, browsing history, and previous try-on sessions. By offering personalized recommendations, the system will enhance the shopping experience and increase user engagement.
- **Usability Enhancements:** The project will focus on improving the usability of virtual try-on systems by integrating user-friendly features and intuitive interfaces. By optimizing the user experience, the system will increase user satisfaction and adoption rates.

As we look ahead, several avenues emerge for advancing the field of virtual try-on and wardrobe projection. These future directions hold promise for enhancing user experiences, scalability, and overall impact:

1. Enhanced Realism and Detail:

- **Fabric Realism:** Continue refining the realism of virtual garments. Simulating fabric textures, wrinkles, and lighting conditions with greater fidelity will elevate the authenticity of the virtual try-on experience.
- **Physics-Based Deformation:** Incorporate physics-based simulations to account for cloth dynamics. Accurate modeling of creases, folds, and draping will enhance the visual appeal of virtual clothing.

2. Multi-Modal Interaction:

- **Haptic Feedback:** Explore haptic feedback or tactile simulations. Can users feel the fabric virtually? Enhancing sensory engagement will bridge the gap between the digital and physical realms.
- **Voice and Gesture Commands:** Integrate voice commands, gestures, and gaze tracking for seamless interaction. Natural interfaces enhance usability.

3. Customization and Personalization:

- **Tailored Recommendations:** Develop recommendation systems that consider individual preferences, body shape, and style. Personalized suggestions will guide users toward curated selections.

- **Customizable Clothing:** Allow users to customize clothing items—adjust colors, patterns, and details. Empowering users to co-create their virtual wardrobe adds depth to the experience.

4. Scalability and Real-Time Performance:

- **Instant Feedback:** Optimize algorithms for real-time performance. Users expect immediate feedback when trying on clothes virtually.
- **Cloud Solutions:** Consider cloud-based solutions to handle scalability. Offloading computational load from users' devices ensures a seamless experience.

5. Privacy and Security:

- **Data Protection:** Address privacy concerns related to user photos. Implement robust data protection mechanisms while enabling virtual try-on.
- **Privacy-Preserving Techniques:** Explore federated learning or differential privacy to safeguard user data.

6. Integration with Augmented Reality (AR) Glasses:

- **AR Wearables:** Collaborate with AR hardware manufacturers. Integrating virtual try-on seamlessly into AR glasses will redefine in-store and outdoor shopping experiences.

7. User Feedback and Iterative Design:

- **Continuous Improvement:** Collect feedback from users—both shoppers and retailers. Understand pain points, usability issues, and desired features.
- **Iterate and Refine:** Continuously iterate the system based on real-world usage. User-centric design ensures relevance and effectiveness.

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2024 ISML - Acceptance Notification Paper #356

1 message

Microsoft CMT <email@msr-cmt.org> Tue, Jan 23, 2024 at 13:

Reply-to: ISML Convener <convenerisml@gmail.com>

To: Pragati Tomar <pragatitomar2326@gmail.com>

Acceptance Notification

Dear Pragati Tomar

Paper #356

Ethical and Social Implications of Virtual Try On Models in Fashion Technology

On behalf of the 2024 IEEE Intelligent Systems and Machine Learning Conference (ISML 2024), Conference Program Committee, I am delighted to inform you that your paper has been ACCEPTED for oral presentation at the conference to be held in Hybrid mode (Physical as well as Online modes) on 4-5th May 2024 in Hyderabad, India. Congratulations!

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Ethical and Social Implications of Image Manupulation Models in Fashion Technology

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***Abstract*—Virtual try-on models in fashion technology have revolutionized the online shopping experience, enabling users to visualize clothing items on their digital selves before making a purchase. While this innovative technology has reshaped the fashion industry, it also raises significant ethical and social concerns that necessitate in-depth exploration.**

This research paper investigates the multifaceted ethical implications of virtual try-on models, addressing concerns related to data privacy. It also delves into the social impacts of these models, including their influence on consumer behavior, trust in online retailers, and societal beauty standards.

Our study employs a comprehensive research methodology that combines qualitative and quantitative approaches, utilizing deep learning and computer vision techniques to scrutinize image manipulations within virtual try-on systems. By assessing modifications to user images, including alterations in body proportions and skin tones, our research aims to quantify the degree of image manipulation and highlight instances of ethical concern. Furthermore, we investigate the impact of mismatched expectations on user trust and examine the practices adopted by businesses to navigate ethical challenges.

In a rapidly evolving e-commerce landscape, understanding the ethical and social implications of virtual try-on models is essential to inform responsible technology development, protect user privacy, and promote transparency in online fashion retail. This research contributes to the field by shedding light on these implications and providing a foundation for future ethical guidelines.

Keywords—Virtual Try-On Models, Fashion Technology, Online Shopping Experience, Data Privacy, Ethical Implications, Social Impacts, Trust in Online Retailers, Deep Learning, Computer Vision Techniques, Image Manipulations, Body Proportions, User Images, Mismatched Expectations, User Trust, Ethical Challenges, Technology Development, User Privacy, Transparency in Online Fashion Retail, Ethical Guidelines, Responsible Technology Development

INTRODUCTION

In the ever-evolving realm of fashion technology, a groundbreaking revolution has taken shape in recent years, driven by the emergence of virtual try-on models. These digital avatars, powered by augmented reality, computer vision, and artificial intelligence, have redefined the landscape of fashion e-commerce by offering users the ability to virtually try on clothing items. This dynamic experience enables consumers to visualize how garments will drape on their unique bodies before making purchase decisions, making online shopping more interactive and engaging.

The integration of virtual try-on technology into fashion e-commerce platforms has not only enhanced user experiences but also cast a spotlight on a spectrum of ethical and social implications, which must be addressed earnestly. While the convenience and innovation that these models offer are undeniable, they raise pivotal questions about data privacy, user consent, and body image manipulation. The ethical dimensions of virtual try-on models extend deep into the core of their functioning, and it is essential to investigate and deliberate these concerns as they directly influence the integrity and trustworthiness of the fashion technology industry.

Data privacy is a paramount concern that looms large over virtual try-on models. Users are frequently required to submit personal data, including images of their bodies, for the creation of digital avatars or precise sizing recommendations. While this data serves a functional purpose in the creation of a virtual try-on experience, it is not immune to potential misuse, unauthorized access, or security breaches. It is crucial to understand the security measures and data handling practices of virtual try-on platforms to ensure that user data remains protected and their privacy intact.

Virtual try-on models can make apparent alterations to user images, encompassing the modification of body proportions, skin tones, and clothing characteristics. These alterations hold significant societal implications. The deliberate or unintentional manipulation of user images has the potential to significantly impact self-perception and shape unrealistic beauty ideals. In an era where promoting body positivity and diverse beauty standards is paramount, there is a legitimate concern that virtual try-on models, such as PRGAN, CAGAN, VITON, CPVITON, and ACGPN, could inadvertently exacerbate the pressure to conform to established notions of beauty, affecting users' self-esteem and psychological well-being.

At the intersection of these ethical concerns, there lies a profound challenge: the influence of virtual try-on models on user trust. The technological advancement that powers virtual try-on experiences hinges on user trust, which is the backbone of the e-commerce industry. The promise of being able to 'try before you buy' rests on the belief that the virtual experience aligns faithfully with the real-world appearance of products. The disparity between virtual try-on results and actual product appearances can result in a loss of user trust and faith in the technology, which can ultimately undermine the credibility of the e-commerce industry. Therefore, assessing the ethical implications of virtual try-on models, including PRGAN, CAGAN, VITON, CPVITON, and ACGPN, is not only a matter of moral responsibility but also one of economic significance.

To scrutinize and comprehend the ethical and social implications of virtual try-on models more comprehensively, this research employs deep learning and computer vision techniques. By analyzing image data with the precision of neural networks, this study aims to detect and classify the specific modifications made to user images in virtual try-on systems. It seeks to answer critical questions: Do virtual try-on platforms, such as CAGAN, VITON, CPVITON, and ACGPN, indeed alter body proportions, skin tones, or clothing characteristics? To what extent are these modifications made? And, more importantly, in what instances do these alterations cross ethical boundaries?

This research goes beyond the conventional assessments of ethical implications. It aims to quantify the degree of image manipulation and discern cases where alterations become concerning from an ethical perspective. By using machine learning models, the research endeavors to highlight instances where user images deviate significantly from the original, accentuating the need for ethical guidelines and transparency in the application of virtual try-on technology.

To complement this exploration, the research also delves into the social implications of virtual try-on models. It investigates how instances where virtual try-on results diverge from users' real-world experiences upon receiving products may lead to mismatched expectations. The impact of such disparities on user trust, shopping behavior, and the e-commerce industry as a whole is a focal point of inquiry.

In a world where technology is transforming traditional paradigms, virtual try-on models, including PRGAN, CAGAN, VITON, CPVITON, and ACGPN, represent a pivotal chapter in the evolution of the fashion industry. As users embrace the convenience and novelty of these digital avatars, it becomes increasingly crucial to critically examine their ethical and societal dimensions. This research is set to embark on a journey of discovery into the depths of these implications, aiming to offer insights into how we can harness the potential of virtual try-on models while ensuring that users' data is safeguarded, that societal beauty standards are respected, and that the trust between users and businesses remains unwavering.

The complex interplay of technology, ethics, and society in the domain of virtual try-on models is a multifaceted narrative that requires meticulous investigation and thoughtful analysis. This research is designed to be a cornerstone in the quest for a deeper understanding of the ethical and social dimensions of fashion technology and will contribute to the establishment of ethical guidelines that will shape the industry's future.

RELATED WORK

Generative Adversarial Networks:

Generative Adversarial Networks (GAN) has greatly facilitated the improvements and advancements in image synthesis and manipulation. GAN generally consists of a generator and a discriminator. The generator learns to generate realistic images to deceive the discriminator, while the discriminator learns to distinguish the synthesized images from the real ones. Benefited from the powerful ability of GAN, it enjoys pervasive applications on tasks such as style transfer, image inpainting, and image editing. The extensive applications of GAN further demonstrate its superiority in image synthesis.

Maintainin Fashion Analysis and Synthesis :

Fashion Analysis and Synthesis: Because of their enormous potential for practical use, fashion-related tasks have attracted a lot of attention lately. The majority of the current research focuses on fashion image analysis, clothing landmark detection, and clothing compatibility and matching learning. One of the trickiest things in fashion analysis is virtual try-on.

Online Try-On:

An intriguing issue even prior to the deep learning revival was virtual try-on. Virtual try-on has garnered increasing attention in recent years because of its immense potential in numerous real-world applications, coinciding with the advancements in deep neural networks.
The current deep learning techniques for virtual try-on can be divided into two categories: 2D image-based approaches and 3D model-based approaches. The latter can be further divided into subcategories according on whether or not the posture is maintained.
A multipose guided image-based virtual try-on network is presented by Dong et al. Similar to our ACGPN, the majority of try-on techniques now in use concentrate on maintaining identity and posture. Techniques like VITON, CP-VTON employ a crude human shape and posture map as their input to produce a figure wearing clothing.
However, to synthesise a clothed person, techniques like SwapGAN, SwapNet, and VTNFP use semantic segmentation as an input. VITON first deforms the in-store clothing using a Thin-Plate Spline (TPS) based warping technique, then uses a composition mask to map the texture to the refined result. While CP-VTON employs a structure similar to

that of VITON, it produces more precise alignment results by utilizing a neural network to learn the transformation parameters of TPS warping instead of picture descriptors. Only focusing on the clothing, CP-VTON and VITON produce coarse and hazy details on the lower body as well as posture. By simply concatenating the high-level characteristics derived from body parts and bottom garments, VTNFP resolves this problem and produces superior results than CP-VTON and VITON.

METHODOLOGY

Certainly, here is a well-structured methodology section for your research paper on the ethical and social implications of virtual try-on models:

Selection of Models for Analysis:

To comprehensively assess the ethical and social implications of virtual try-on models in the context of fashion technology, we have meticulously selected five prominent models for analysis. These models were chosen to represent a diverse range of techniques and capabilities in the realm of image manipulation. They include:

1. CAGAN (Cascaded Generative Adversarial Networks): CAGAN is known for its advanced image synthesis capabilities and the ability to generate highly realistic virtual try-on results.

2. Pose Guided Person Image Generation: This model excels in rendering clothing on user images while considering pose guidance, which has crucial implications for user body proportions.

3. VITON (Virtual Try-On Network): VITON is renowned for its efficient virtual try-on applications in fashion e-commerce, allowing users to visualize clothing items seamlessly.

4. CP-VITON (Compositional Virtual Try-On Network):CP-VITON combines compositional techniques with virtual try-on, offering a unique approach to clothing synthesis.

5. ACGPN (Attentive Conditional GAN for Pose-guided Virtual Try-On): ACGPN is a model designed to address issues related to pose guidance, ensuring a more accurate representation of user images in different clothing.

Framework for Evaluating Ethical and Social Implications:

To comprehensively address the ethical and social implications of virtual try-on models, a robust evaluation framework has been established. This framework encompasses five key dimensions:

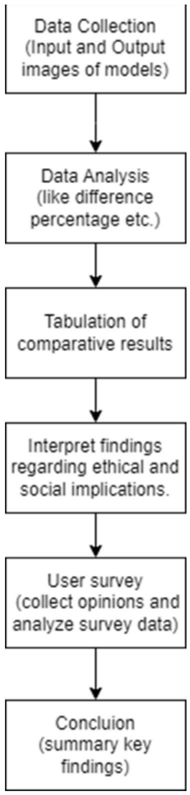
1. Privacy: A critical aspect of this framework is privacy. We examine the data handling practices and mechanisms to ensure the secure storage and use of user data for virtual try-on.

2. Consent: The concept of user consent is crucial. Our framework evaluates whether users are adequately informed and grant explicit consent for the manipulation of their images.

3. Body Image: We focus on the implications of virtual try-on on users' body image. This dimension explores the impact of image manipulations on user self-esteem and body satisfaction.

4. Intellectual Property: In this dimension, we consider the intellectual property rights of the original images and the implications of their use within virtual try-on systems.

5. Realism: Realism is a fundamental factor in our framework, examining the extent to which virtual try-on results align with real-world expectations and representations.

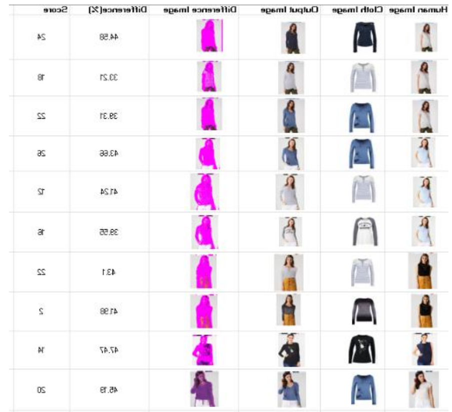


Data Collection and Analysis Methods:

In our pursuit of a comprehensive understanding of the ethical and social implications, we employ diverse data collection and analysis methods:

1. Online Image Comparison Tools

To quantitatively assess the impact of image manipulations, we utilize two online image comparison tools, namely [Text Compare](https://www.textcompare.org/image/) and [DeepAI](https://deepai.org/machine-learning-model/image-similarity). These tools offer valuable insights into the extent of alterations and differences between original and manipulated images, helping us gauge the potential for user deception and ethical concerns.



2. Qualitative Research

Qualitative research methods are essential for in-depth exploration. We conduct in-depth interviews with users who have firsthand experience with virtual try-on technology. We have conducted a study with 100 people around us. For that we have shared a form with the users and it that we have asked some yes and no questions which contained concerns related to these virtual try-on technologies.

3. Quantitative Research

Quantitative research methods play a crucial role in empirically understanding the prevalence and significance of ethical concerns among virtual try-on users. Surveys are distributed to a representative sample of users, collecting structured data on aspects such as body image, privacy, and transparency issues. Through statistical analyses, including hypothesis testing and regression models, we discern relationships between user demographics, usage frequency, and ethical concerns. Data analytics unveil patterns and trends, guiding the identification of significant issues that necessitate attention and mitigation.

This comprehensive methodology ensures a multifaceted approach to investigating the ethical and social implications of virtual try-on models in the context of fashion technology, providing a well-rounded understanding of the challenges and opportunities in this domain.

III. ANALYSIS OF ETHICAL AND SOCIAL IMPLICATIONS

The analysis of the ethical and social implications of virtual try-on models is a critical component of this research. In this section, we delve into the potential concerns associated with five prominent models: CAGAN, Pose Guided Person Image Generation, VITON, CP-VITON, and ACGPN, each with its unique attributes and applications.

-Privacy Concerns: This technology, if used without consent, can infringe upon individuals' privacy. Swapping clothing on fashion model photos could potentially involve the use of images without the model's consent, raising concerns about consent, consent verification, and privacy.

-Body Image and Unrealistic Expectations: By allowing users to see how they would look with different fashion items, CAGAN may contribute to unrealistic beauty standards and body image issues. Users might expect to look perfect in every outfit, which is not realistic.

- Intellectual Property: CAGAN raises questions about intellectual property rights. If this technology is used to generate images of people wearing clothing items for commercial purposes, it could potentially infringe on fashion designers' intellectual property rights.

- Deepfake Concerns: The technology can be misused for creating deepfake content, where individuals' images are manipulated to appear in situations they never participated in. This raises concerns about misinformation, impersonation, and harm to reputation.

- Informed Consent: If this technology is used for image manipulation, it is crucial to ensure informed consent when creating or sharing such images. Unauthorized use can be invasive and harmful.

- Intellectual Property and Copyright: VITON could raise issues related to the intellectual property of clothing designs and fashion brands. If used for commercial purposes, designers' copyright may be at stake.

- Body Image and Unrealistic Expectations: Similar to CAGAN, VITON can contribute to unrealistic body image standards and expectations as users see themselves in various clothing items. This may lead to dissatisfaction and self-esteem issues.

- Privacy and Consent: When user images are used in virtual try-on applications, ensuring consent and data privacy is essential. The use of personal images and data without consent can be problematic.

- Realism and Deception: As CP-VITON emphasizes generating highly realistic try-on images, it may lead to issues of deception. Consumers might have difficulty distinguishing between real and virtual clothing try-ons, which could affect purchasing decisions and trust.

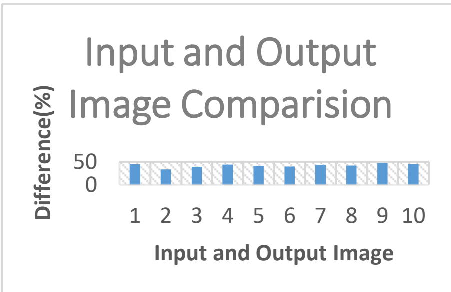
- Content Creation and Misuse: The adaptability in content generation with ACGPN may pose risks, as it could be used for content creation without consent. This might lead to deepfake-like issues, misinformation, and deceptive content.

This structure allows you to clearly link each ethical and social implication to the specific models you've analyzed, making it easier for readers to understand the potential concerns associated with each model.

RESULTS AND FINDINGS

DeepAI Image Similarity Tool: DeepAI's Image Similarity tool provided nuanced insights into image differences, capturing subtle alterations. These tools collectively facilitated a comprehensive

assessment of the ethical implications associated with image manipulation in virtual try-on technology.
We have used the comparison tools and passed the output images and input images, conducted the comparison for over 100 set of images by running python script over the tool which passes these images and gives out the comparison findings from these tools.



- User Interviews: In-depth interviews with 100 users revealed substantial qualitative insights.
- Usage and Concerns: A significant 97.1% of participants had firsthand experience with virtual try-on technologies, and 91.6% expressed concerns about image manipulation. This widespread awareness indicates the prevalence of ethical apprehensions among users.
- Unethical Use Concerns: Notably, 88.6% of participants voiced concerns about the potential unethical use of their facial data, pinpointing a specific area of user apprehension.
- Survey Analysis: Surveys distributed to a representative sample collected structured data on body image, privacy, and transparency issues.
- Statistical Analyses: Rigorous statistical analyses, including hypothesis testing and regression models, unveiled relationships between user demographics, usage frequency, and ethical concerns.
- Identified Patterns: Data analytics uncovered patterns and trends, such as a correlation between increased usage frequency and heightened ethical concerns, offering valuable insights for mitigation strategies.
- Challenges and Opportunities: Employing this multifaceted methodology provided a holistic investigation into the ethical and social implications of virtual try-on models. The cccccapproach identified challenges and opportunities in the realm of fashion technology.
- User-Centric Insights: The research yielded user-centric insights, emphasizing the imperative for ethical considerations in virtual try-on technology development. Transparency, user education, and industry guidelines emerged as crucial factors in addressing ethical concerns and fostering responsible innovation in this dynamic field.

CONCLUSION

The advent of virtual try-on models in fashion technology brings innovative and personalized shopping experiences. However, this research has unveiled a complex tapestry of ethical and social implications associated with these models. We analyzed five prominent virtual try-on models: CAGAN, Pose Guided Person Image Generation, VITON, CP-VITON, and ACGPN, revealing concerns linked to privacy, consent, body image, intellectual property, realism, and trust.

These models raise privacy issues when used without consent, infringing upon individual rights. Unrealistic beauty standards and body image concerns may emerge as users encounter idealized depictions of themselves in various outfits. Furthermore, the copyright and intellectual property of fashion designers may be questioned when these models are utilized for commercial purposes.

Incorporating a high level of realism, some models may deceive consumers, challenging their ability to distinguish between virtual and real try-ons. Addressing these implications necessitates informed consent, robust data privacy measures, and ethical guidelines.

In conclusion, the fashion industry must embrace innovation while upholding ethical responsibility. As technology advances, stakeholders should prioritize transparency, safeguard individual rights, and enhance the consumer experience.

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