Final Year B.Tech. Project-II Report

On

Enhancing Online Shopping: A Virtual Try-On Solution

For the Degree of

Bachelor of Technology
In

Computer Science and Engineering

Submitted by

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AY 2024-25

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CERTIFICATE

This is to certify that the Project Report entitled, **"Enhancing Online Shopping: A Virtual Try-On Solution"** submitted by

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to **Walchand College of Engineering, Sangli**, India, is a record of bonfire Project work of course **"PROJECT-I (5CS491)"** carried out by them under our supervision and guidance and is worthy of consideration for the award of the degree of Bachelor of Technology in Computer Science & Engineering during the academic year ***2024-25***.

Prof. Vaibhav Mali

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Declaration

I hereby declare that work presented in this project report titled **"Enhancing Online Shopping: A Virtual Try-On Solution"** submitted by us in the partial fulfillment of the requirement of the award of the degree of Bachelor of Technology (B. Tech) Submitted in the Department of Computer Science & Engineering, Walchand College of Engineering, Sangli, is an authentic record of my project work carried out under the guidance of (Guide(s) name and affiliation).

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Thank you.

Abstract

In the current landscape of online shopping, a significant challenge customers face is the inability to physically try on clothing before making a purchase. This limitation leads to uncertainty regarding the fit, style, and appearance of garments on an individual's body, resulting in a high rate of returns and dissatisfaction. Existing e-commerce platforms lack a seamless and realistic virtual try-on experience that allows customers to visualize how clothing items will look on them, ultimately reducing confidence in online purchases. Our project addresses this issue by developing a sophisticated virtual try-on feature for e-commerce platforms. Utilizing advanced AI and machine learning techniques such as image segmentation, geometric matching, and generative modeling, this project offers a realistic and interactive solution that allows users to visualize how clothing will look on them. By enhancing the online shopping experience, this innovation aims to boost customer confidence, reduce return rates, and provide a competitive advantage for e-commerce platforms. The project also emphasizes scalability, user privacy, and continuous improvement, ensuring a modern and effective solution to a common problem in the industry.

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CHAPTER 1: INTRODUCTION

1.1. Introduction

The rapid growth of e-commerce has reshaped how people shop, with online platforms offering a convenient way to browse and purchase clothing from virtually anywhere. However, the inability to physically try on garments before purchasing is a significant drawback in online shopping. This limitation often leaves consumers uncertain about how clothing will fit and look on them personally, leading to frequent returns, increased costs for retailers, and overall customer dissatisfaction. For customers, challenges include choosing the right size, understanding how a fabric will drape, and visualizing the overall look of an outfit on their unique body. Our project, *Enhancing Online Shopping: A Virtual Try-On Solution*, seeks to address these challenges by developing an advanced virtual try-on system that allows users to see clothing on themselves before making a purchase. Through the integration of image processing and machine learning techniques, the project aims to create a realistic, interactive try-on experience where users can upload their images and visualize how clothing would fit and look on their bodies. By bridging the gap between online and in-store experiences, this solution is designed to increase confidence in purchasing decisions, reduce return rates, and improve customer satisfaction in the online shopping process.

1.2 Literature Review

E-commerce platforms are continuously evolving to address the significant challenges consumers face when shopping for clothing online. One prominent area of research is the development of virtual try-on (VTO) technologies that leverage advanced image processing and machine learning techniques to enhance the customer shopping experience.

Numerous studies have conducted surveys on the current landscape of virtual try-on technologies, identifying crucial challenges that hinder broader adoption. These challenges often include issues related to fit accuracy, clothing deformation, and user experience. For instance, the inability of existing systems to provide realistic try-on experiences frequently results in high return rates due to customer dissatisfaction [1].

Machine learning techniques, particularly convolutional neural networks (CNNs) and generative models, have made significant strides in the realm of virtual try-ons. Research has demonstrated that models such as Mask R-CNN and U-Net are effective for body segmentation tasks, allowing for more precise virtual fitting of garments [1][2][3]. Furthermore, generative networks like VITON and TryOnGAN have been proposed to enhance the realism of the synthesized try-on images by accurately deforming clothing items to conform to the user's body shape [4][5].

Numerous works emphasize the importance of robust data collection and preprocessing for effective virtual try-on systems. It is critical to gather diverse datasets that include a wide variety of clothing styles and body types. Studies suggest utilizing platforms such as Deep Fashion and Fashion-MNIST to obtain labeled

datasets that encompass a range of clothing attributes and user characteristics [6][7]. Thorough preprocessing techniques, including data cleaning and normalization, are essential for improving model performance and accuracy in virtual try-ons, as highlighted by existing literature [8].

The evaluation of virtual try-on systems is critical for assessing their performance and user satisfaction. Existing studies propose metrics such as Intersection over Union (IoU) for segmentation performance and user-focused metrics, including perceived realism and satisfaction, for the overall virtual try-on experience [9]. A recent survey highlighted the need for standardized evaluation frameworks to facilitate comparisons among different virtual try-on methodologies [10].

Research has also explored how virtual try-on technologies impact consumer behavior. A study showed that VTO significantly enhances user engagement, leading to higher confidence in purchasing decisions, thus mitigating the common challenge of online shopping uncertainty [11]. Virtual try-ons can lead to increased conversion rates while reducing return rates, making them a valuable feature for e-commerce platforms [12].

With the rise of augmented reality, many projects integrate AR capabilities into virtual try-on systems to create immersive shopping experiences. For example, several applications allow users to view clothing items in real-time as they overlay digital garments onto themselves using smartphone cameras [13]. Innovations in AR are projected to drive further advancements in the virtual try-on landscape as e-commerce continues to merge physical and digital experiences [14].

In summary, this literature survey on virtual try-on technologies highlights the continuous advancements made in this field. Current challenges related to fitting accuracy, model integration, and consumer engagement are being addressed through innovative machine learning techniques and data collection methods. By building upon these findings, our project aims to deliver a robust and user-friendly solution that enhances online shopping experiences.

1.3 Research Gap

Virtual try-on (VTO) technologies, a prominent research focus, use advanced image processing and machine learning to improve the shopping experience. However, current virtual try-on solutions encounter several limitations, known as research gaps, which hinder their effectiveness and broader adoption.
Some of the main gaps identified in VTO research are:
High Cost and Device Constraints: Many VTO systems require expensive equipment or high-performance devices, making them inaccessible for a broad audience.

1. **Image Quality Issues:** Distortion and pixelation are common, causing the virtual try-on experience to appear unrealistic and unsatisfactory.
2. **Lack of Realistic Clothing Fit**: Existing systems struggle to accurately replicate clothing styles and proportions, resulting in a poor representation of fit.
3. **Personalization Limitations**: Few systems use user-specific measurements, which leads to less precise recommendations and sizing inaccuracies.
4. **Inconsistent Size Perception:** Achieving realistic size representation is challenging due to calibration inconsistencies between real and virtual environments.

5. **Low-End Device Compatibility:** Virtual try-ons are often not optimized for mobile or low-end devices, limiting accessibility for a large user base.
6. **Privacy and Inclusivity Concerns:** VTO systems raise ethical questions due to the use of personal images and data, highlighting the need for robust privacy protections.
7. **Unrealistic Body Models**: Current VTO technologies sometimes lack realistic body modeling, resulting in inaccurate try-on representations.
8. **Limited Clothing Variety:** Many VTO systems only work well with specific clothing types or materials (e.g., tops or dresses), lacking adaptability to different styles, textures, or complex designs like layered outfits.
9. **Real-Time Performance Issues:** Current systems may struggle with processing speed, causing delays and reducing the smoothness of the try-on experience, especially when handling high-resolution images or complex garments.
10. **User Body Diversity:** Existing VTO models often lack the capability to accurately reflect diverse body shapes, sizes, and postures, which limits their usefulness across different demographics.
11. **Lighting and Background Sensitivity:** The accuracy of virtual try-ons is often affected by variations in lighting or background, leading to inconsistencies in the visual quality and realism of the try-on experience.
12. **Scalability Challenges:** Integrating VTO features across large e-commerce platforms can be technically challenging, especially when scaling to support high traffic or multiple product types.
13. **Lack of User Feedback Integration:** Few VTO systems incorporate user feedback (e.g., preferred styles, fit preferences) to personalize future recommendations, which limits the adaptability of the platform.
14. **Dynamic Pose Adaptability:** Many current VTO models do not handle dynamic poses well, so users must often stand in a static position, reducing the interactivity and realistic feel of the try-on.
15. **Environmental and Ethical Concerns:** The computational power required for VTO systems may have a high environmental impact, and ethical considerations, such as ensuring inclusive representations, remain under-addressed.

These gaps reveal areas where VTO technology can be further refined to enhance adaptability, realism, and user engagement, making virtual try-ons a more versatile and accessible feature in online shopping.

These research gaps present valuable opportunities for advancing VTO systems. Improvements in affordability, image quality, personalized fit, and privacy could enhance realism, accessibility, and user trust. Addressing these challenges through further research and technological innovation would improve user satisfaction and reduce return rates, making virtual try-ons a more effective tool for online shopping.

1.4. Problem Statement

To develop an application that solves the problem of online shoppers struggling to see how clothing will fit and look, reducing uncertainty, returns, and dissatisfaction by providing a more realistic and engaging virtual try-on experience before purchase.

1.5 Significance

The significance of this project lies in its potential to transform the online shopping experience for both consumers and retailers. Current virtual try-on solutions often lack accuracy and realism, which limits their effectiveness in replacing in-store fitting experiences. This project offers an innovative solution that enhances the realism of virtual try-ons, making it possible for consumers to make better-informed purchasing decisions without needing to visit a store.

Key areas of significance include:

1. **Customer Satisfaction**: By allowing shoppers to see how clothing will look on their unique body type, the project aims to address one of the biggest uncertainties in online shopping, thereby increasing customer confidence and satisfaction.
2. **Reduction in Return Rates**: Improved accuracy in virtual fit and appearance will likely lead to fewer returns, benefiting both retailers and customers by saving time, cost, and resources. For retailers, this also means fewer losses associated with returns and restocking.
3. **Increased Accessibility**: This solution has the potential to make shopping easier for people who may not have easy access to physical stores or have limited time for in-person shopping. The virtual try-on system enables a realistic shopping experience from anywhere, supporting a growing demand for online convenience.
4. **Advancement in E-commerce Technology**: As e-commerce continues to grow, virtual try-on solutions are expected to play a significant role in setting platforms apart from competitors. By contributing to the technological innovation in this area, this project could drive forward developments in online retail, setting a new standard for customer experience.
5. **Potential Application Beyond Fashion**: While focused on clothing, the solution's underlying technology could be applied to other areas in e-commerce, such as accessories, eyewear, or cosmetics, offering a foundation for broader use in digital retail.

By addressing the common challenges of fit accuracy, style representation, and realism, this project offers a scalable and impactful solution that aligns with the future needs of online shopping. The project ultimately seeks to improve user engagement, foster customer loyalty, and support the sustainable growth of the e-commerce sector.

1.6. Research Objectives

The primary objectives of this research are as follows:

1. **To create a User-Focused Virtual Try-On System**: Build a system where users can see how clothes look on their own uploaded photos instead of digital avatars.
2. **To enhance Realism and Fit Accuracy**: Make the virtual try-on experience look and feel more realistic by accurately showing how clothes fit and drape on the user's image.
3. **To ensure Compatibility Across Devices**: Design the system to work well on different devices, including mobile and low-end devices, so it's accessible to a wide range of users.

4. **To boost User Confidence and Satisfaction**: Improve user confidence in buying clothes online by giving a clear and accurate visualization before purchase.
5. **To reduce Return Rates**: Help lower return rates by making online clothing shopping more reliable and reducing fit-related issues.
6. **To prioritize Privacy and Security**: Protect users' personal data and images with secure practices to build trust and follow privacy standards.

CHAPTER 2: METHODOLOGY

2.1 Overview

The Virtual Dressing Room is a software application built to provide users with an interactive experience of virtually trying on clothing items. This project leverages computer vision, specifically pose detection, to overlay a selected item, such as a t-shirt, onto a user's image or live video. Built using Python, PyQt5 for the interface, and OpenCV for image and video processing, this application offers users three modes to try on clothing: via a photo, a pre-recorded video, or real-time video capture.

2.2 Requirements Gathering and Design

2.2.1 Objective

The primary objective of the project is to enable users to visualize how they would look wearing certain clothing items without physically trying them on. To achieve this, specific requirements for the application were defined:

- Users should have options to upload an image, a video, or use real-time video capture to try on clothing.
- The application should detect the user's shoulder positioning accurately to align the overlaid clothing image.
- A user-friendly interface should allow easy navigation through each functionality.

2.3 Implementation

2.3.1 Project Structure

The project is divided into two main components:

- **GUI Component (Main Window)**: Manages user interactions, including file selection and mode switching (photo, video, real-time).
- **Processor Component**: Contains methods for processing images and videos by overlaying selected clothing items onto the user's image.

2.3.2 GUI Development

The GUI was developed using PyQt5. Key sections of the GUI include:
Main Window: Allows users to choose from “Try with Image,” “Try with Video,” and “Try with Real-time Capture” options.

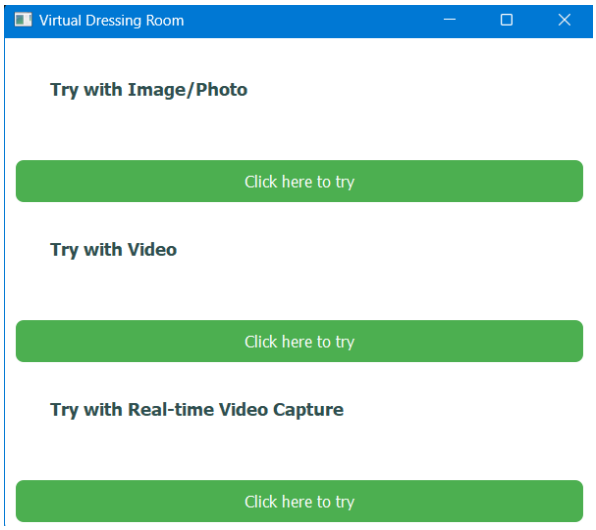


Fig.1 Main Window

Try with Image Window: Allows users to upload a static image of themselves and a clothing item to visualize.

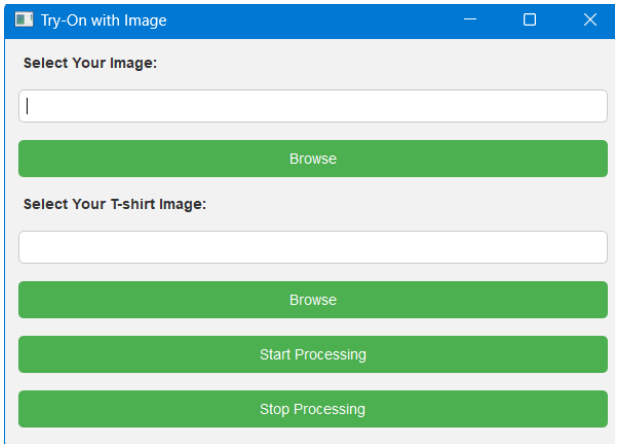


Fig.2 Image Try-On

Try with Video Window: Enables users to upload a video of themselves wearing the clothing virtually.

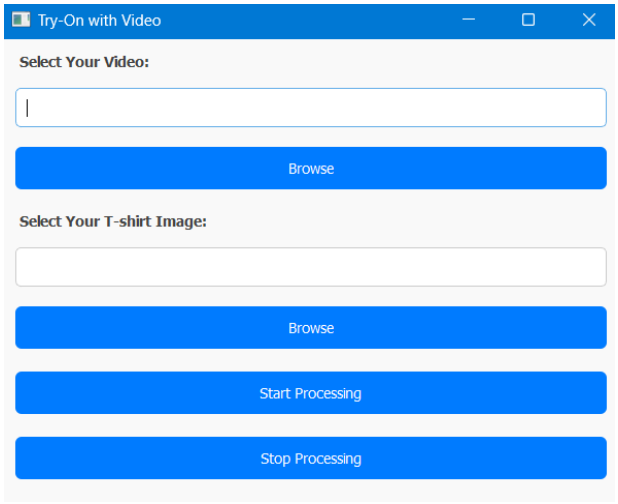


Fig.3 Video Try-On

Try with Real-time Capture Window: Integrates with the webcam for real-time clothing try-ons.

Each mode provides buttons for file selection (using `QFileDialog`), and processing starts upon clicking the "Start Processing" button.

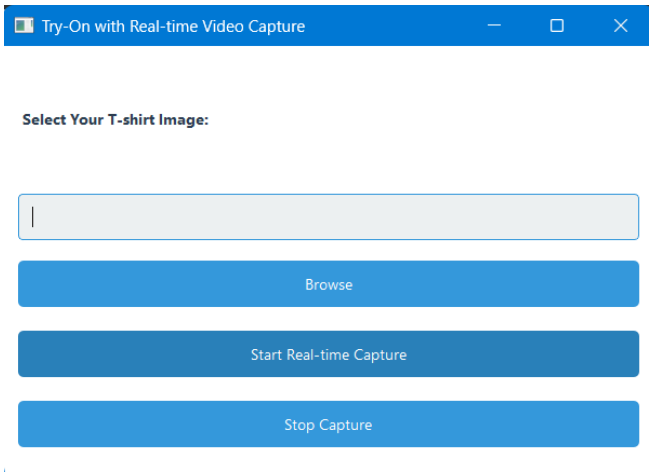
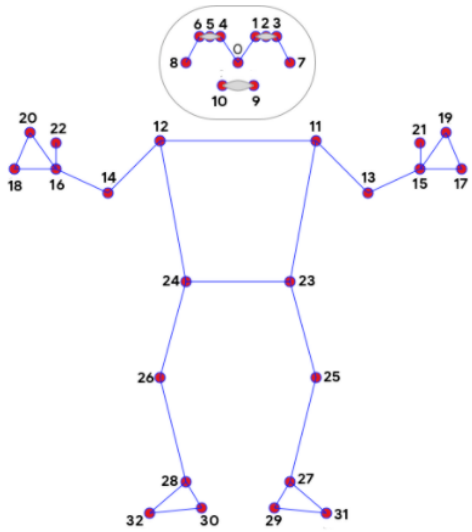


Fig.4 Real Time Try-On

2.3.3 Pose Detection and Overlay

Pose detection is achieved using the `Pose Detector` module, which detects the user's shoulder positions:

- **Image Processing**: When an image is uploaded, the pose detector finds key landmarks such as shoulder positions. The clothing item is then resized and aligned based on these positions and overlaid onto the image.
- **Video and Real-Time Processing**: For video and real-time modes, frames are processed in a loop, continuously detecting shoulder positions and overlaying the clothing item in sync with the user's movements.



0. nose
1. left_eye_inner
2. left_eye
3. left_eye_outer
4. right_eye_inner
5. right_eye
6. right_eye_outer
7. left_ear
8. right_ear
9. mouth_left
10. mouth_right
11. left_shoulder
12. right_shoulder
13. left_elbow
14. right_elbow
15. left_wrist
16. right_wrist
17. left_pinky
18. right_pinky
19. left_index
20. right_index
21. left_thumb
22. right_thumb
23. left_hip
24. right_hip
25. left_knee
26. right_knee
27. left_ankle
28. right_ankle
29. left_heel
30. right_heel
31. left_foot_index
32. right_foot_index

Fig.5 Pose Tracking Full Body Landmarks

2.4 Diagrammatic Representation

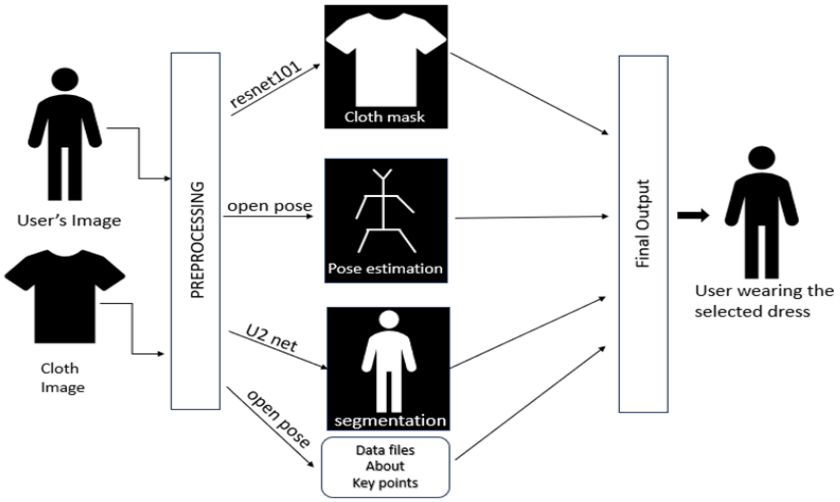


Fig.6 Functional Block Diagram

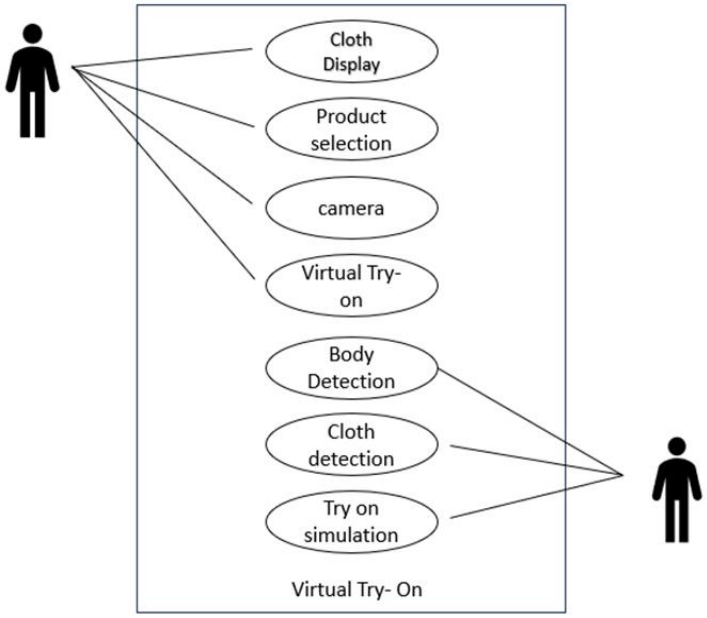


Fig.7 Use Case Diagram

CHAPTER 3: Data Set Description and Technology Stack

3.1 Dataset Structure

1. **Image Type**: The dataset consists of PNG images, which often feature a transparent background. This transparency allows the garment (shirt) to be easily isolated and placed over the user's image without additional processing to remove the background.
2. **Image Resolution**: High-resolution images are commonly used to retain garment details, such as texture, color, and stitching, which are important for realistic visual representation in try-on applications. Image sizes typically range from 512x512 pixels to 1024x1024 pixels, depending on the application needs.
3. **Garment Types**: The dataset may include a variety of shirts, such as:
    - **T-shirts**
    - **Polo shirts**
    - **Dress shirts**
    - **Long-sleeve and short-sleeve options**
    - **Various colors, patterns, and textures**

3.2 Dataset folder structure

- |-**Resources**
- |--**Shirts**
- |---shirt.png
- |---tshirt.png
- |---polo.png.png
- |---formal.png
- |--**Videos**
- |---video_tryon.mp4

3.3 Technology Stack

- **Cvzone**: High-level computer vision library built on top of OpenCV for easier image and video processing.
- **Opencv-python**: Open-source library for computer vision, image, and video processing.
- **Pillow**: Imaging library that provides capabilities to manipulate images in Python.
- **PyQt5**: Python bindings for the Qt application framework, for building cross-platform GUI applications.
- **OpenPose**: OpenPose is a real-time multi-person key point detection library used for detecting human body, face, hand, and foot key points in images or videos.

CHAPTER 4: RESULTS AND ANALYSIS

4.1 Functional Testing

Each functionality of the application was individually tested to ensure smooth operation:

- **Image Upload and Processing**: Testing involved uploading various user images and t-shirt designs to verify accurate positioning and overlay.

Fig.8 Image Try-On Output

- **Video Upload and Processing**: Checked with different video files to ensure that the t-shirt overlay remains in sync with the user's movement.

- **Real-time Capture**: Tested for real-time pose detection and overlay alignment with the user's movements in various lighting and background conditions.

The Virtual Dressing Room successfully integrates computer vision techniques with a user-friendly interface to deliver a virtual try-on experience. It provides a foundation for future developments, such as adding more clothing types, improving accuracy with advanced models, and enabling online retail integration.

CHAPTER 5: CONCLUSIONS AND FUTURE SCOPE

5.1. Conclusion

The Virtual Try-On Solution for online shopping represents a significant advancement in the e-commerce industry, providing a transformative shopping experience for users who can now visualize garments in a personalized and interactive manner. By integrating advanced AI techniques, such as image segmentation, geometric transformation, and generative modeling, the proposed system addresses common challenges in online shopping, such as size uncertainty, fit issues, and customer dissatisfaction. This innovative approach not only enhances user confidence but also has the potential to reduce return rates, benefiting both consumers and retailers. Moreover, the scalable and privacy-aware architecture ensures that this solution is ready for widespread adoption, catering to a diverse range of fashion e-commerce platforms.

Beyond practical implementation, this project demonstrates the importance of AI and machine learning in revolutionizing online retail by blending physical and digital experiences. The Virtual Try-On system aligns with future market trends, such as augmented reality integration and personalization, to provide a seamless shopping experience. As technology and fashion continue to intersect, virtual try-on capabilities will likely become a standard feature in online shopping, influencing consumer behavior and setting new standards for customer satisfaction. This solution not only holds great promise for e-commerce growth but also highlights the continuous need for innovation, ensuring that fashion retailers can stay competitive in an increasingly digital marketplace.

5.2 Major Achievements

The development of a Virtual Try-On Solution for e-commerce has led to several key achievements that set the foundation for a transformative online shopping experience. First, we successfully integrated advanced AI models, including segmentation networks and generative models, to achieve a realistic and responsive virtual try-on feature. This system allows users to visualize how clothing items would look on them, thereby improving their confidence in making purchases online. Another significant achievement was the successful implementation of real-time fitting and deformation algorithms, which enable accurate clothing adjustments based on individual body shapes and poses, enhancing the overall user experience. Additionally, the solution is designed with scalability and privacy measures, ensuring it can handle high user volumes while protecting user data, which is critical for e-commerce platforms aiming for widespread adoption.

Moreover, the project has established a robust evaluation framework with metrics for segmentation accuracy, user satisfaction, and overall system performance, enabling continuous monitoring and improvement. The integration with existing e-commerce platforms through APIs and plugins is another notable achievement, allowing seamless implementation without requiring extensive overhauls of current systems. These accomplishments not only demonstrate the technical feasibility of virtual try-on solutions but also pave the way for more immersive, personalized, and efficient online shopping experiences.

5.3 Future Scope

The future scope for Virtual Try-On solutions in e-commerce is expansive and promising, driven by advancements in AI, augmented reality (AR), and computer vision. In the near future, the incorporation of 3D body scanning and advanced AR capabilities could elevate the realism and interactivity of virtual try-on experiences, allowing users to view garments from multiple angles and simulate how fabrics move. With continuous improvements in machine learning, models can be trained to adapt to a wider range of clothing types, patterns, and body shapes, enabling more precise recommendations and styling options for diverse customer preferences.

Further, integrating virtual try-on solutions with fashion recommendation systems and user preference analysis could provide a holistic shopping experience, guiding users toward products that suit their style, fit, and comfort. Additionally, there is scope for enhancing the platform's adaptability to global fashion trends, creating region-specific recommendations that evolve with market demands. As privacy and security remain paramount, the system can be refined with advanced encryption and compliance with international data protection standards to build greater user trust. In the long term, virtual try-on technology could fundamentally reshape the fashion industry by bridging the gap between physical and digital retail, offering personalized, accessible, and sustainable shopping experiences for consumers worldwide.

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