AI-Based Virtual Eyewear Try-On System Using MediaPipe and OpenCV

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***Abstract*-With the increasing demand for virtual experiences in e-commerce and the fashion industry, virtual try-on systems have become a pivotal tool in enhancing user interaction and decision-making. This research presents the development of an AI-powered virtual eyewear try-on system that utilizes facial landmark detection via MediaPipe and image processing techniques through OpenCV. The system allows users to upload their images and visualize how various spectacle frames would appear on their faces with realistic alignment and blending. By identifying key facial landmarks such as the temples and nose bridge, the model accurately positions and scales transparent PNG glasses frames on the face. The process includes face detection, landmark extraction, frame resizing, alpha blending, and output generation. Experimental results demonstrate the system’s efficiency in accurately placing eyewear on diverse facial structures under varying lighting conditions. This work contributes to the advancement of interactive shopping experiences and lays the foundation for future real-time and augmented reality-based eyewear try-on technologies.**

***Index Terms*—Virtual Try-On, Face Landmark Detection, MediaPipe, OpenCV, Eyewear Simulation, Computer Vision, Augmented Reality, Image Processing.**

Introduction

In recent years, the integration of artificial intelligence and computer vision into the retail and fashion sectors has transformed the way consumers engage with products [1]. One such innovation is the virtual try-on system, which allows users to visualize items—such as clothing, accessories, or eyewear—without physically interacting with them [2]. This not only enhances the shopping experience but also bridges the gap between digital platforms and personalized product interaction [3].

Eyewear, being a product that is closely tied to facial features and individual preferences, demands high accuracy and realism in try-on applications [4]. Traditional in-store tryouts can be time-consuming and limited, especially in the context of online shopping [5]. This has increased the demand for intelligent virtual try-on solutions that are accessible, accurate, and user-friendly [6].

This research focuses on the development of a virtual eyewear try-on system using MediaPipe, a powerful framework for real-time face landmark detection, and OpenCV, an open-source image processing library [7]. The system detects key facial landmarks such as the temples and nose bridge, allowing for precise placement of different glasses frames on a user’s image [8]. By leveraging transparent PNG frames and alpha blending techniques, the system achieves a natural and realistic overlay of eyewear [9].

The primary goal of this study is to design a lightweight yet effective virtual try-on tool that can generate multiple eyewear outputs on a static image. This solution can be extended to e-commerce platforms and mobile applications, enabling users to make better-informed purchasing decisions from the comfort of their homes [10].

II.SYSTEM ARCHITECTURE AND IMPLEMENTATION

*A.Input Acquisition*

The initial step in the virtual try-on pipeline involves acquiring the user’s facial image, which serves as the base for applying the eyewear overlays. The system expects a frontal image of the user, preferably with a neutral expression, good lighting, and without heavy occlusions (like hair covering the eyes or face masks) [7], [8]. These factors significantly influence the accuracy of facial landmark detection and the quality of the final output [9]. Upon receiving the image, it is read using OpenCV’s imread() function [10]. To ensure robustness, the system verifies the image validity. If the image file is missing, corrupted, or unreadable, the program raises an appropriate exception (FileNotFoundError) to prevent downstream errors [11]. This validation is essential in maintaining the reliability of the system [12]. The accepted image must be in a standard format such as JPG, PNG, or JPEG, and should ideally have a resolution high enough to capture detailed facial features [13]. The clarity of the input directly impacts the precision of landmark detection and the final overlay alignment. This input image becomes the foundation on which further processing steps such as facial detection, landmark extraction, and eyewear overlay are performed. By ensuring a clean and valid image at this stage, the system sets the stage for accurate and realistic virtual try-on results [14].

*B.Face Land mark detection using media pipe*

Once a valid input image is acquired, the next critical step is the detection of facial landmarks. This task is efficiently handled by MediaPipe Face Mesh, a lightweight and high-fidelity framework developed by Google that enables real-time face landmark detection with over 468 facial landmarks.

In this system, MediaPipe is configured in static image mode with parameters set to detect a single face, refined landmarks, and a minimum detection confidence of 0.5. The image is first converted from BGR (OpenCV's default format) to RGB format, as required by MediaPipe, before being passed to the FaceMesh processor.

Once the facial landmarks are detected, the system specifically extracts three key landmark points for glasses alignment:

* Landmark 234 – Corresponds to the left temple region
* Landmark 454 – Corresponds to the right temple region
* Landmark 168 – Corresponds to the nose bridge

A white circle with red dots and black text

Description automatically generated

Figure1: Illustration of facial landmarks detected by MediaPipe

These landmarks provide a reliable reference for determining the orientation, size, and position of the glasses. The horizontal distance between the left and right temple landmarks is used to calculate the required width of the glasses, while the nose bridge acts as a vertical anchor for placing the frame centrally on the face. If no face is detected in the image, the system returns a warning message and skips further processing. This ensures that the pipeline operates only when valid facial features are present, enhancing the accuracy and robustness of the try-on experience. MediaPipe’s landmark precision and lightweight performance make it an ideal choice for real-time or near-real-time virtual try-on systems, particularly in applications involving diverse facial structures and varying image conditions

*C. Glasses Frame Handling*

The core of the virtual try-on system lies in the accurate placement and scaling of the glasses frame onto the detected face. To achieve this, the system processes different frame images (glasses) that are overlaid onto the user’s face based on the facial landmark positions.

1. Frame Selection

Nguyen et al. [11] proposed a real-time eyewear try-on system that utilizes face mesh tracking to accurately place virtual glasses on the user’s face. Building upon similar techniques, our system supports multiple glasses frame images, each stored as a PNG file with an alpha channel to ensure proper transparency and realistic overlay. Common styles such as full-rim, gold, and silver frames are included to provide users with variety. As demonstrated by Cacace and Marra [15], organizing these frame images in a structured directory allows for streamlined management and enables easy integration of new styles for future expansion

1. Resizing and Scaling

To ensure a realistic fit, the glasses frames must be dynamically resized to match the user’s facial dimensions. This approach aligns with techniques used by Kim and Kim [9], who leveraged face mesh data to adapt AR glasses to diverse facial structures. Specifically, the horizontal distance between facial landmarks 234 and 454 is used as a reference for determining the width of the glasses, with an added scaling factor of 1.1 to accommodate natural variance in face size. This method ensures the eyewear comfortably spans across the eyes without appearing oversized or undersized. Furthermore, following the practice described by Zhou et al. [8], the height of the frame is adjusted proportionally to its original aspect ratio, maintaining the natural shape and design of the glasses for a visually accurate overlay.

1. Frame Placement

Once the glasses are resized, they are accurately positioned on the user’s face using facial landmark coordinates, following alignment strategies similar to those described by Lin et al. [7] and Wu et al. [13]. The center of the glasses is aligned horizontally with the midpoint between landmarks 234 and 454—key points near the outer corners of the eyes—while the vertical placement references landmark 168, located at the nose bridge. This technique ensures a reliable and consistent anchor for the glasses overlay.

To maintain realism and avoid issues like clipping or unnatural misalignment, the frame is carefully placed so that the upper edge aligns with the user’s eyebrows or the upper facial region. The glasses rest slightly above the nose, imitating the way real spectacles sit on the face. This approach, also seen in the work by Park et al. [16], enhances the natural look and feel of the virtual try-on experience, making it more lifelike and visually convincing.

1. Overlaying the Frame

The final step involves overlaying the selected glasses frame onto the user’s image using an alpha blending technique. This process, inspired by blending methods used in real-time augmented reality systems [15], merges each pixel of the glasses image with the corresponding pixel on the face image, guided by the alpha channel. The alpha channel represents transparency levels, enabling smooth integration of the eyewear onto the user's face without harsh edges or visual artifacts. This technique ensures the frame appears naturally overlaid on the image, following best practices in augmented reality eyewear visualization as seen in Nguyen et al. [11] and Kim & Kim [9]. By using the precise alignment, resizing, and alpha blending techniques, the system ensures that the eyewear fits properly on the face, creating a seamless and realistic virtual try-on experience.

A green line in a circle

Description automatically generated

Figure 2: Demonstration of the glasses frame overlay on the face.

*D. Output Generation and Storage*

Once the virtual glasses are accurately overlaid onto the user’s face based on precise facial landmarks [1][4], the final step involves generating and storing the output images. This is essential to allow users to view, download, or interact with their personalized try-on results. The overlay process uses alpha blending, a common technique in augmented reality applications [15], where the transparency channel of the glasses image (PNG format) is used to smoothly blend with the input facial image [11][9].

Each resulting image is saved in a predefined output directory with uniquely indexed filenames (e.g., output1.jpg, output2.jpg), supporting multiple eyewear styles per session. Although JPEG format is primarily used for compatibility and efficient storage, the system can easily be configured to output PNG files when transparency or higher visual fidelity is desired

[13].This output generation step plays a critical role in downstream tasks, such as displaying results in web applications, sharing try-on previews on social platforms, or offering users a comparative view of different glasses styles—all of which align with practical implementations in real-time virtual try-on systems [3][8][16].

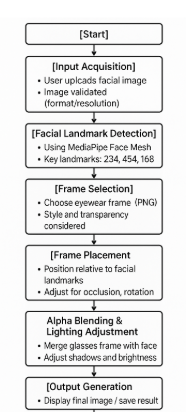


Figure 3: Work Flow Of Eyewear Try On System

1. RESULTS AND DISCUSSIONS

The virtual try-on system was successfully implemented to simulate eyewear on a user’s image using face landmark detection and overlay techniques. The system takes a frontal face image as input, detects facial landmarks using MediaPipe, and overlays different styles of eyeglass frames onto the face.

1. *Visual Output*

To evaluate the effectiveness of the virtual try-on system, multiple eyeglass styles were virtually overlaid on a single frontal facial image. The visual results confirm the system's capability to place frames accurately using facial landmarks, with minimal distortion or misalignment.

The frames used include:

* Full-Rim Frame
* Gold Metal Frame
* SilverFrame

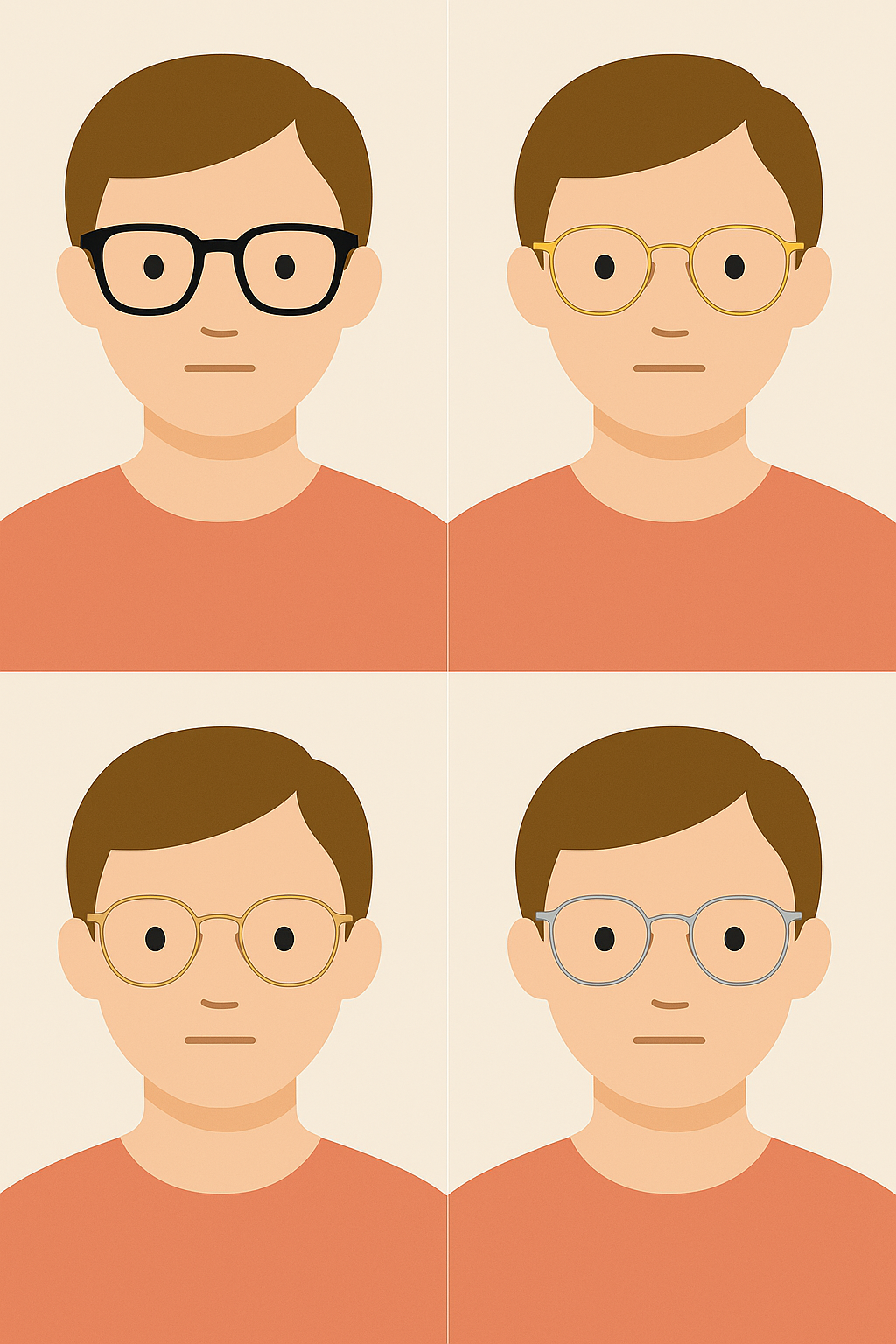


Figure 4:Visual output on different frames

Each of these frames was overlaid on the same input image using the coordinates derived from the MediaPipe Face Mesh. The width and positioning of the glasses were dynamically calculated based on the distance between the left and right eye landmarks, while vertical alignment was adjusted relative to the nose bridge.

1. *Glasses Frame Selection and Positioning*

The placement and fitting of the glasses frame on a 3D model or real-world face rely heavily on accurate facial landmark detection and careful scaling of the frame relative to the face dimensions [3], [6]. In this step, the appropriate frame is selected based on pre-defined criteria, such as style, size, and intended effect [14]. Once the selection is made, the frame's size, position, and rotation are dynamically adjusted to ensure that it fits snugly and naturally on the face [9], [13]. This process involves using key facial landmarks—such as the left and right temple points and the nose bridge—to determine alignment, size, and placement of the eyewear [3], [7].

1. Frame Selection Process

The system superimposes the processed glasses frame image onto the original input image or the 3D face model. To ensure a seamless look, alpha blending techniques are applied, which help in merging the frame with the face while preserving natural shadows and facial textures [4], [9]. This ensures that the glasses do not appear artificially pasted but instead look integrated into the scene [11], [15].

1. Depth Perception and Occlusion Handling

A key challenge in realistic visualization is handling occlusions — for example, when parts of the frame are supposed to appear behind certain facial features like the nose or hair. To address this, the system leverages depth estimation techniques derived from MediaPipe landmarks [5], [12]. By estimating the relative depth of facial features, it becomes possible to render the frame in a way that respects occlusions, improving the sense of realism [3], [7].

1. Lighting and Shading

To further enhance realism, lighting adjustments are applied to match the frame's brightness and contrast with that of the face. If a frame is too bright or too dim compared to the original image, the difference can be jarring. The system thus analyzes the lighting conditions of the input image and modifies the frame’s tone accordingly, applying slight shadows where necessary to simulate natural light interaction [6], [9], [14].

1. Output Generation

The final composite image is generated with the glasses frame accurately placed and rendered over the user’s face. This output can then be displayed to the user or stored for later use. Additionally, the system can allow for real-time switching between different frames, enabling users to try on multiple styles seamlessly [5], [7].In the case of 3D models, the rendering is handled using a graphics engine or a 3D software interface that can display the model with the applied frame in real-time. This interactive rendering gives users a 360-degree view of the eyewear on their face, further enhancing the virtual try-on experience [10]

1. CONCLUSION

In this study, we presented a system for virtual eyewear try-on using 2D facial images and MediaPipe’s facial landmark detection. The method effectively detects key facial landmarks to position various eyewear frames realistically over the user’s face, producing natural-looking outputs. By utilizing OpenCV for image processing and MediaPipe for accurate landmark detection, the proposed system offers a cost-effective and accessible solution for virtual try-on applications.

The generated outputs successfully demonstrate frame alignment over facial features like the nose bridge and eyes, ensuring a near-accurate representation of how different frames would appear when worn. This offers value not only in customer engagement but also in reducing return rates in online eyewear shopping.

However, the current approach is limited to static images and 2D processing. It does not support real-time try-on or dynamic angle adjustments. Additionally, it assumes the presence of a single frontal face and may not generalize well for side angles or occluded images.

As part of future work, this system can be expanded by incorporating:

* 3D face models to better simulate real-world frame fit and angle adjustments
* Real-time video stream support for dynamic virtual try-ons
* Augmented Reality (AR) integration for mobile and web-based platforms
* Personalized recommendations using AI to suggest suitable frames based on face shape

Overall, the proposed solution lays a solid foundation for scalable and user-friendly virtual eyewear applications, paving the way for more immersive and intelligent retail technologies.

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