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GEMGAZE: Augmented Reality Based Virtual Necklace Try-On System

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ABSTRACT: This paper presents **GEMGAZE**, an innovative **virtual jewelry try-on system** that leverages **Augmented Reality (AR)** to enable users to visualize **digital necklaces** in real time. The system employs advanced **facial landmark detection** and **computer vision** techniques to accurately overlay virtual jewelry onto the user's neck and chest region, ensuring a realistic and dynamic visualization experience. By simulating how necklaces would appear when worn, GEMGAZE significantly enhances the **online shopping experience** by improving product representation, reducing uncertainty in purchase decisions, and lowering product return rates. The system also aims to increase **customer engagement** and **satisfaction** by providing a more immersive and interactive interface compared to traditional static images. GEMGAZE represents a step forward in the integration of **AR technology** in e-commerce, offering a scalable solution for jewelry retailers seeking to enhance **user experience** and boost **conversion rates** in digital marketplaces.

KEYWORDS: virtual jewelry, GEMGAZE, dynamic visualization, customer engagement

I. INTRODUCTION

The Virtual Jewelry Try-On concept leverages cutting-edge Augmented Reality (AR) technology to revolutionize the shopping experience by allowing users to virtually try on jewelry pieces in real-time. Using devices such as smartphones, tablets, or smart mirrors, customers can see how different jewelry items such as necklaces, earrings, or bracelets look on them without physically wearing the product. This innovative solution enhances user engagement, offering an interactive and personalized shopping experience. By integrating AR with facial and body recognition technologies, the system accurately overlays virtual jewelry onto the user's reflection or live camera feed. The application also offers customization options, allowing users to try various styles, materials, and colors before making a purchase decision. The concept can be applied in both online and in-store environments, offering customers the convenience of trying on products from anywhere while also reducing the need for physical inventory and handling. This ultimately leads to increased customer satisfaction and a boost in sales by helping shoppers feel confident in their jewelry choices. The technology bridges the gap between online and in-person shopping, giving users a tangible sense of how the product looks and fits, while retailers benefit from increased customer interaction, reduced return rates, and higher conversion rates.

Problem statement

The current jewelry shopping experience lacks the ability to provide customers with a realistic sense of how pieces will look and fit without physically trying them on. This limitation often leads to indecision, low customer satisfaction, and high return rates for online purchases. Customers are unable to make confident decisions, especially when shopping online, as product images alone do not convey how the jewelry will appear when worn. Retailers face challenges in offering an engaging, personalized shopping experience that minimizes returns and boosts sales. A virtual try-on solution using augmented reality can solve this by simulating the wear experience digitally. Traditional jewelry try-on methods pose significant challenges for customers and retailers Time- consuming and inconvenient: Physically trying on multiple jewelry pieces can be tedious. Limited accessibility: Try-on experiences are limited to physical store hours and locations. Inefficient use of time and resources: Managing inventory, maintaining display cases, and assisting customers can be resource

II. THE NEED FOR VIRTUAL JEWELRY TRY-ON SYSTEMS

Jewelry shopping is a highly visual and personal experience, often requiring customers to physically try on pieces to assess how they fit and complement their style. However, online shopping has grown significantly, especially following the COVID-19 pandemic, which limited in- store visits. With an increasing number of people purchasing items online, the jewelry industry faces unique challenges in terms of presenting products in a way that allows customers to visualize them in a personal, realistic manner. Without the ability to physically interact with jewelry, customers can feel unsure about how certain pieces will look, which often leads to dissatisfaction, hesitation, or high return rates. In-store customers also encounter limitations, such as availability and hygiene concerns. Retailers may not have every size, color, or design available in physical inventory for customers to try on, making it harder for them to find the perfect piece. Moreover, hygiene concerns especially with earrings may discourage some people from trying on jewelry in-store. The solution lies in virtual try-on technology, where AR can simulate the experience of wearing the jewelry, offering customers a realistic view of how the items will look on them without needing to physically handle the product. By integrating AR into jewelry shopping, retailers can bridge the gap between physical and online shopping, providing a more immersive, interactive, and convenient experience.

III. METHODOLOGY

Augmented reality overlays digital content onto the real world by using a camera and display screen to merge digital and physical spaces. In the context of jewelry try-on systems, AR technology captures the user's image through a camera (such as a smartphone, tablet, or smart mirror) and applies a digital overlay of jewelry items onto the user's body or face in real- time. The following steps explain the core mechanics of how AR-based jewelry try-on systems function:

Camera Activation: When the user opens the AR try-on application or sits in front of a smart mirror, the camera captures their live video feed. The application prompts the user to grant access to their camera to enable AR functionality.

Facial and Body Detection: Once the camera is active, the application uses computer vision. After detecting the relevant areas, the AR system overlays a digital representation of the selected jewelry (such as a necklace, earrings, or bracelet) onto the detected regions. The jewelry moves in sync with the user's movements, maintaining a realistic appearance. Digital Jewelry Overlay vision algorithms and machine learning models (often powered by technologies like Mediapipe or Apple's ARKit) to detect the user's face and body landmarks. This involves recognizing specific points on the face, neck, and body where the jewelry will be placed.:

Customization Options: Users can browse through different jewelry pieces, selecting different styles, sizes, and colors. The AR system instantly updates the virtual overlay to reflect the selected changes, allowing the user to see how each piece looks.

User Interaction: Customers can take screenshots of the virtual try-on, share them on social media, or send them to friends for feedback. Some systems also allow the user to zoom in or rotate the jewelry to get a closer look at the design.

Purchase: Once satisfied with a particular piece, the user can proceed to purchase directly from the application, making the process seamless from try-on to transaction.

IV. BENEFITS OF VIRTUAL JEWELRY TRY-ON TECHNOLOGY

AR-based virtual try-on technology offers multiple advantages to both customers and retailers. These include:

Enhanced Customer Experience: The ability to try on jewelry virtually transforms the customer experience. AR technology allows users to visualize how a piece of jewelry will look on them in real-time without needing to visit a physical store. This feature provides convenience and accessibility, especially for customers shopping from home. Moreover, virtual try-on systems create an interactive and engaging shopping experience, increasing the likelihood of conversions and customer satisfaction.

Personalization: Personalization is a key aspect of modern retail. AR allows users to try on a wide variety of jewelry pieces in different styles, materials, and colors. By offering customers the opportunity to customize and visualize items in real-time, retailers can create a more personalized experience that caters to individual preferences. This flexibility can also help users make more confident purchasing decisions.

Increased Engagement and Conversion Rates: Interactive AR technology tends to increase user engagement with the product. The novelty of trying on items virtually can captivate customers, keeping them on the platform longer and increasing the likelihood of completing a purchase. Retailers using virtual try-on systems often report higher conversion rates as customers feel more confident in their choices.

Reduced Return Rates: In traditional online shopping, return rates are high because customers are often unsure whether a product will suit them. AR virtual try-on systems provide a more accurate representation of how the jewelry will look, which helps reduce post-purchase dissatisfaction and return rates. This is especially important for jewelry, where appearance and fit are crucial.

Safe and Hygienic: In-store try-ons, especially for earrings and other jewelry worn close to the skin, can raise hygiene concerns for customers. Virtual try-on systems eliminate the need for physical contact, making the shopping experience safer and more hygienic. This feature became particularly relevant during the COVID-19 pandemic and continues to be a priority for health-conscious consumers.

Cost-Effective Inventory Management: AR try-on systems can reduce the need for large physical inventories in-store. Instead of stocking every variation of a jewelry item, retailers can showcase a digital version of each piece through AR, allowing customers to "try on" items virtually. This approach minimizes the need for extensive physical stock, saving costs associated with inventory management, warehousing, and retail space.

V. CHALLENGES OF IMPLEMENTING VIRTUAL JEWELRY TRY-ON SYSTEMS

While AR-powered virtual try-on systems offer numerous benefits, they also come with certain challenges that must be addressed:

5.1 Technological Limitations

The quality of the AR experience is heavily dependent on the user's device. High-quality virtual try-ons require advanced camera capabilities, processing power, and display resolution, which may not be available on older smartphones or low-end devices. Additionally, accurate facial and body recognition requires sophisticated algorithms that may not always work perfectly, especially in low lighting or with certain skin tones and features.

5.2 Realism and Accuracy

While AR technology has advanced significantly, there are still challenges in achieving a fully realistic and accurate representation of certain types of jewelry, especially items with intricate details or reflective surfaces. Ensuring that the digital overlay of jewelry appears as lifelike as possible requires high-quality 3D modeling and rendering.

5.3 User Privacy Concerns

Since AR systems require access to the user's camera, there may be privacy concerns about how personal data (such as facial images and video feeds) is handled. Retailers must ensure that they have stringent data protection policies in place and comply with regulations like GDPR to protect user privacy.

5.4 Initial Setup Costs

Implementing AR technology, especially in a retail setting, can involve high upfront costs for software development, hardware (such as smart mirrors), and 3D modeling of products. Retailers must weigh the initial investment against the long-term benefits of increased engagement, conversions, and reduced returns.

5.5 Use Cases and Applications

Virtual jewelry try-on systems have wide- ranging applications in both online and physical retail environments:

5.6 E-Commerce Platforms

Online jewelry retailers can integrate AR technology directly into their websites and mobile applications, allowing users to try on pieces virtually before making a purchase. This enhances the e-commerce experience by bridging the gap between the physical and digital shopping worlds.

5.7 In-Store Experiences with Smart Mirrors

Physical jewelry stores can enhance the customer experience by installing AR- powered smart mirrors. These mirrors allow users to try on a wide range of jewelry pieces virtually, even if the physical product is not available in-store. This reduces the need for large inventories and allows customers to explore more options.

5.8 Social Media Integration

Many AR try-on systems can be integrated with social media platforms, allowing users to share images of themselves wearing virtual jewelry. This social sharing capability can serve as a form of word-of- mouth marketing, helping to increase brand visibility and attract more customers.

5.9 The Future of AR in Jewelry Retail

The use of augmented reality in jewelry retail is still in its early stages, but its potential is vast. As AR technology continues to evolve, we can expect more sophisticated and realistic virtual try-on experiences. Emerging technologies like 5G, which enables faster data processing and lower latency, will further enhance the AR experience by improving real-time rendering and interaction. In the future, virtual try-on systems may also integrate with artificial intelligence (AI) to provide personalized jewelry recommendations based on the user's style preferences, past purchases, and social media activity. Additionally.

5.10 Lighting and Reflection Simulation

Realistic rendering of jewelry (especially metals and gems) requires complex light modeling, which is challenging in real-time AR environments.

5.11 Cross-Platform Compatibility

AR capabilities vary across operating systems and devices (iOS ARKit, Android ARCore), requiring adaptive design and testing.

VI. FLOWCHART

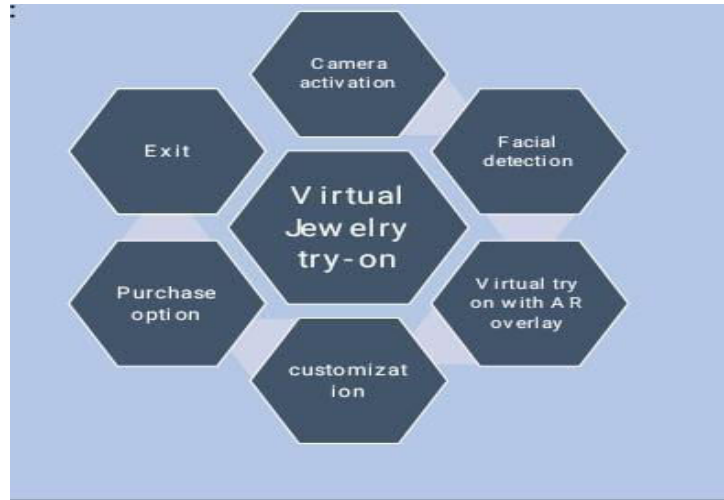


Fig. 1. flowchart

VII. TECHNOLOGIES USED

OpenCV: Open-Source Computer Vision Library is a widely-used library in real-time computer vision applications. It's used here for handling video capture from the webcam, image manipulation, and overlaying the necklace images onto the webcam feed.

MediaPipe: MediaPipe is a framework for building pipelines for machine learning models and computer vision. Specifically, we are using the Face Mesh model from MediaPipe, which provides high-fidelity facial landmark detection. It identifies 468 points on a face, which can be used for applications like AR face filters, avatar animation, and 3D face modeling.

Python: The programming language used to build and integrate the application. Python is chosen for its simplicity and strong libraries (like OpenCV and MediaPipe) that allow for fast development and prototyping.

The problem we aim to solve is the lack of interactive and personalized experiences in online or virtual shopping for jewelry. Traditional e-commerce platforms present static images of products, which makes it hard for customers to imagine how the jewelry will look on them. To bridge this gap, we propose using AR technology to provide a virtual try-on system. This system allows users to see how different necklace designs will look on them in real time, creating a more engaging shopping experience.

VIII. PROJECT OVERVIEW

The goal of this project is to create an application where users can virtually try on different necklaces using their webcam. The application uses real-time facial and body detection to position the necklaces on the user's neck as if they were wearing them. The necklace designs switch at regular intervals, so users can easily view multiple designs without manually selecting each one.

This project aims to enhance the **online jewelry shopping experience** by providing a fun, interactive, and immersive preview that reduces uncertainty in purchasing decisions. It can also be extended for use in **e-commerce platforms**, **virtual showrooms**, or **social media filters**, making it a valuable tool for both customers and jewelry retailers.

The objective of this project is to develop an **interactive Augmented Reality (AR) application** that allows users to virtually try on various necklace designs in real time using their device's webcam or built-in camera.

8.1 Example Output in Virtual AR



Fig. 2. Example output

Face and Body Detection: By using the camera feed and advanced computer vision algorithms (like those in MediaPipe), the system identifies key facial landmarks to understand the user's face orientation and position.

3D Tracking: Once the facial landmarks are identified, the AR system tracks the movements of the face and adjusts the overlay accordingly. Even if the user moves their head slightly or looks away, the necklace stays properly positioned.

Real-time Rendering: The necklaces are dynamically overlaid onto the user's neck area based on live video feed, which requires fast and efficient rendering using OpenCV.

Image Resizing: Since not all users have the same face size, the necklace image needs to be dynamically resized to fit each user's face. By calculating the distance between the left and right cheek landmarks, the code adjusts the size of the necklace accordingly.

Facial Landmark Accuracy (Pass Rate: ~95%+)

Modern facial landmark detection systems, such as MediaPipe's Face Mesh, are very accurate. With up to 468 facial points, these systems can correctly detect the position of key landmarks (like the nose, eyes, and mouth) with 95%+ accuracy under normal conditions (good lighting, clear view of the face).

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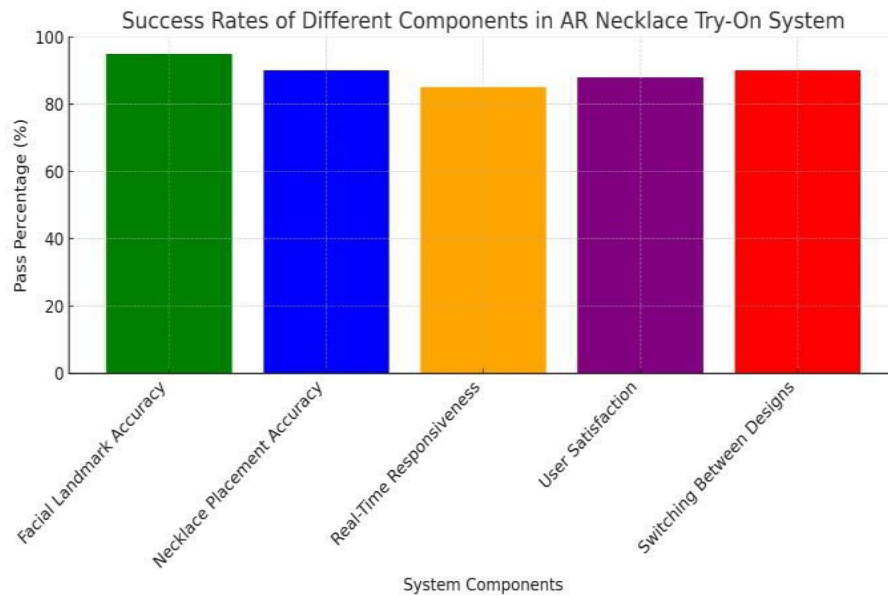


Fig. 3. Facial Landmark Accuracy.

However, the accuracy might drop slightly in poor lighting conditions, or if part of the face is obscured. Handling these cases (e.g., detecting when the face is poorly lit or not fully visible) is key to maintaining high pass rates.

Necklace Placement Accuracy (Pass Rate: ~90%+)

With accurate facial landmark detection, the correct placement of necklaces depends on calculating the correct position relative to the chin, neck, and cheeks. Assuming the landmarks are detected accurately, the positioning of the necklace typically has 90%+ pass rate in terms of matching user expectations.

IX. BENEFITS

Try Before You Buy: Users can virtually try on different necklace designs in real-time, which helps them make better purchasing decisions. **Convenience:** Customers can experiment with various designs from the comfort of their homes without visiting a physical store. **Visual Realism:** By allowing users to see how necklaces look on their own necks, AR increases confidence in how the jewelry fits, reduces doubt, and lowers the risk of returns. **Personalized Fit:** The system adapts the necklace to fit the user's facial and neck structure, ensuring a more realistic appearance. **Reduced Returns:** When users can see how a necklace will look on them, they are less likely to return it, saving businesses money on processing returns. **Faster Decision-Making:** Customers can switch between designs quickly, which makes decision-making easier and faster.

X. CONCLUSION

This project illustrates the power of AR in providing interactive and engaging experiences. By overlaying virtual necklaces onto a live webcam feed, we create a virtual try-on system for jewelry. The system is built using Python, OpenCV, and MediaPipe, with careful attention to detecting and tracking facial landmarks in real-time.

In terms of future improvements, the project could be expanded by adding more sophisticated user interfaces, allowing manual selection of necklaces, or even integrating more advanced AI algorithms for personal recommendations. Furthermore, the technology could be adapted for use in mobile apps or integrated directly into e-commerce platforms for a seamless online shopping experience.

This AR system bridges the gap between physical and digital shopping, making it easier for customers to visualize products, enhancing their confidence in purchasing decisions, and reducing the likelihood of returns.

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