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AI-Based Augmented Reality Smart Shopping Assistant

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ABSTRACT

The fast-changing nature of e-commerce sites has greatly changed the retail sector as it allows people to shop easily at a distance. Nevertheless, a common drawback of online clothing shopping is the inefficient possibility to touch and wear clothes prior to the purchase decision. This usually creates confusion, dissatisfaction and high product returns. In order to overcome this problem, this study suggests an Artificial Intelligence (AI)-powered Augmented Reality (AR) Smart Shopping Assistant that offers a real-time virtual try-on experience with computer vision and web-based technologies. The system proposed combines body landmark detection, automatic background removal and dynamic image overlay features to enable users to view clothing items on their bodies by using a web camera interface. The application is created under the Django framework with the MediaPipe-pose detection as the method of locating the shoulder and body landmarks. The architecture is user-authentication-supported, product-management-supported, and real-time visualization, which is why it can be applied to contemporary e-commerce applications. The deployment minimizes the manual preparation of images and enhances the confidence in decision making among the users. The results indicate opportunities of integrating artificial intelligence and augmented reality to enhance digital shopping experiences and aid the creation of intelligent retail platforms.
Keywords: Augmented Reality, Artificial Intelligence, Virtual Try-On, Computer Vision, E-commerce, MediaPipe, Django, Web Application.

I. INTRODUCTION

Traditional retail stores offer the customer a chance to physically test the garments prior to buying them which gives them an opportunity to assess its fit, style, and comfort. Online websites, however, use mostly static pictures of the products and size charts, which do not reflect well on how the clothing will look on a person. This drawback tends to create uncertainty in making buying choices and leads to higher rates of returns. The product exchanges, logistics and inventory management costs related to returns can lead to extra operational costs incurred by retailers.

The latest developments in Artificial Intelligence (AI) and Augmented Reality (AR) technologies can be seen as the sources of promising solutions to these problems. With a computer vision algorithm, it is possible to identify the body parts of a human, in real-time, and allow digital objects to align with the body of the user. AR enables virtual objects to be superimposed on real-time camera views, resulting in interactive and immersive experience. Using these technologies in e-commerce systems, virtual fitting rooms can be simulated that can reproduce in-store experiences.

The main aim of the study is to plan and execute a web-based AR smart shopping assistant that can provide real-time visualization of clothes using the use of standard web browsers. The system is supposed to enhance the level of user interaction and lessen the hesitation in making a buying choice, as well as increase the overall satisfaction in shopping. In addition, the site makes it easier to prepare products to be sold, as tasks such as background removal and image processing are automated. This paper shows how the current AI-based visualization technologies can be incorporated into scalable web applications to development of intelligent retail solutions that can bridge the divide between the physical and online shopping experiences.

II. RELATED WORK

Zhe Cao et al. (2021) proposed a real-time human pose estimation system that can identify various body landmarks in real-time video streams. The authors were interested in the accuracy of body joint detection to facilitate gesture recognition and visualization of virtual clothes. Their study indicated that pose estimation with high reliability greatly improves the correspondence of virtual objects to human body movements. The system was however, consuming a lot of computational power and this influenced performance on the low-end hardware settings.

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The authors of the research presented by Joseph Redmon et al. (2016) have introduced the YOLO object detection algorithm that can process an image in a single pass through a neural network to make it faster to detect objects than the traditional methodology. The authors have pointed out the significance of real time detection in applications that require continuous video processing. Their work demonstrated that optimized detectors can enhance responsiveness in interactive applications like augmented reality applications. However, there might be a decrease in detection accuracy of the algorithm under circumstances of occlusion or low light intensity.

Ronald Azuma (1997) established the background ideas of augmented reality systems, which entail incorporation of virtual objects in real-world surroundings that can interact in real-time. The author noted the need to have a very close correspondence between the digital content and the physical objects to ensure realistic visualization. This study formed the theoretical basis of the current augmented reality applications in the online shopping and virtualization of products Mark Billinghurt et al. (2018) explored the methods of interaction between users in augmented reality spaces with an emphasis on enhancing the quality of visualization and the usability of the system. The authors have shown that interactive AR interfaces contribute highly to the user engagement and decision-making procedures in online shopping platforms. Their results showed that responsive system design and effective rendering mechanisms are needed to ensure the smooth visualization performance. The research has further indicated that the complicated AR systems need to be optimized well so that they can work in real-time.

Tobias Langlotz et al. (2020) examined how augmented reality technology can be used in retail and ecommerce platforms. The authors examined the role of visualization of virtual products in enabling customers to assess products before they decide to make a purchase. Their study showed that augmented reality platforms enhance customer trust and minimize product returns in online stores. The success of such systems is however, heavily pegged on the stability of the network and effective data processing methods.

IKEA Place application, an application developed by IKEA (2017), allows people to visualize furniture in their homes with the use of cameras on mobile devices. The system revealed the usefulness of augmented reality in enhancing customer experience and aiding the purchase decision-making process. The app allowed visualization and interaction of products in real time. However, the system had several drawbacks like the need to have a high-performance mobile device and good internet access to ensure smooth visualization.

Yann LeCun et al. (2015) highlighted the importance of deep learning algorithms in enabling intelligent decision-making systems. The authors paid attention to neural networks as the means of pattern recognition and automated user behavior analysis. They found that machine learning can be used to enhance recommendation systems and online shopping platforms to be more personalized. Nevertheless, deep learning models have a high computational power and large datasets are needed to train and optimize them. Yang, Zhang, and Li (2017) recently analyzed full-duplex relay selection in physical layer security. For maximum system limits and the characteristics of the relay, the optimal relay selection strategies are provided to optimize the secrecy rate. Their work has outlined the significance of relay selection in achieving the optimal level of secrecy performance and brought insightful information into designing wireless relay networks.

Google (2019) examined web-based augmented reality technologies, which can be used directly in the modern web browsers. The authors concentrated on making it more accessible so that it did not require any special software. They found that browser-based AR solutions are flexible in their deployment on a variety of devices including smartphones and desktop systems. However, compatibility problems with browsers and shortcomings in rendering performance are still obstacles to large-scale implementation.

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Dieter Schmalstieg and Tobias Hollerer (2016) provided a very detailed guide to the development of augmented reality systems, such as tracking systems, rendering pipeline, and system architecture building blocks. The authors have highlighted the need to align hardware and software modules to achieve proper visualization. Their study also gave recommendations on how to create effective AR applications in business. Complexity of system integration may, however, raise the time of development and the cost of implementation.

Large-scale image recognition systems that have been developed using deep learning methods have been developed by Fei-Fei Li (2018). The author aimed at enhancing the classification accuracy through training models on large image datasets. The study proved that good quality datasets enhance the reliability of the system when used in computer vision like object detection and virtual product visualization. One of the constraints that were discovered in the study was the time and resources needed to prepare and label large data sets.

III. EXISTING SYSTEM

The available online shopping systems are mostly concentrated on online product listing, payments and order management services. Such sites offer vital features like product search, customer reviews, and secure transactions. Although these attributes provide operational efficiency, they fail to deal with limitations that come with product visualization in the apparel sector.

The classical forms of e-commerce present clothing in the form of still pictures taken at fixed angles. Customers have to make an individual decision as to whether the garment would fit or not. Body shape, posture and clothes style differences in most cases lead to the creation of an inaccurate expectation. This could therefore result in customers getting products that are not of their choice which may result in dissatisfaction and returns. The other weakness of the current systems is that there is no interactive visualization. Users are not able to see how clothing can be adjusted to body movements or changes in size. Moreover, to post product photographs online, manual image editing is sometimes necessary to take out backgrounds of the photographs. This procedure works against the sellers and creates discrepancies in the presentation of products.

Also, real-time computer vision or augmented reality is not integrated into most existing systems. Due to this, user experience is non-personalized and almost unchanged. These issues have underscored the necessity of a highly sophisticated system that can provide interactive and intelligent visualization functionalities to enhance customer confidence and streamline the e-commerce processes.

IV. PROPOSED SYSTEM

The suggested system presents a virtual try-on system based on AI-powered augmented reality that is planned to be used as a shopping assistant in a web browser. The system is a combination of the computer vision, machine learning, and web development technologies to establish an interactive platform that will improve the process of online shopping. The system architecture is based on a modular architecture comprising of three main layers:

- Presentation Layer
- Application Layer
- Data Layer

The presentation layer deals with the interaction and visualization of the users via responsive Web interfaces. Application layer deals with business logic and image processing and communication among system components. Data layer contains user data, product data and system configuration in a structured database setting.The system allows users to turn on cameras of their device, recognize body markers, and dynamically overlay clothes. This feature provides a virtual fitting experience that is realistic and enables the customer to visualize the items of clothes prior to buying them.

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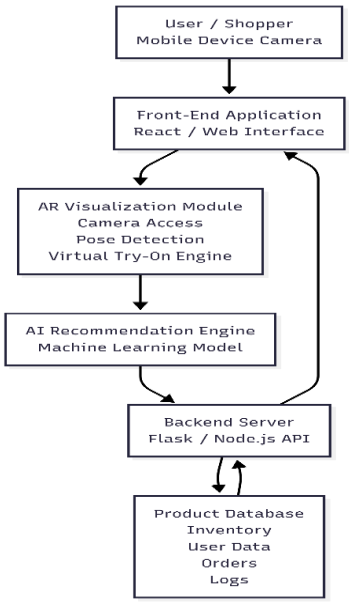


Fig 1: System Architecture of the AI-Based Augmented Reality Shopping Assistant

The system architecture is a modular client server architecture that is in line with the IEEE software engineering practices. The front-end interface is connected to the user via a mobile device, with a camera. AR Visualization Module is a module that uses pose detection algorithms to match the virtual products to the bodies of the user in real-time video frame processing. The AI Recommendation Engine examines customer preferences and past-histories to make tailored product recommendations. The backend server provides a means of communication between modules, authentication and business logic processing, and the product database is securely storing inventory and user information. The layered architecture guarantees scalability, maintainability and efficient real time performance that is necessary in the modern e-commerce applications.

4.1 Methodology:

The proposed system has several phases in its methodology that collaborate in providing real-time augmented reality visualization. The system has an organized workflow, which provides effective processing and proper results.

A. Data Collection

The images of clothes are gathered online in product catalogs or uploaded by sellers via system interface. These pictures are used as input data to do the visualization and background removal.

B. Image Preprocessing

The images of clothes uploaded are preprocessed to eliminate unwanted background objects. A segmentation algorithm that is an AI-based algorithm recognizes the region of clothing and transforms the image into a transparent form. This is a better step in enhancing accuracy of overlay in visualization.

C. Pose Detection

The system works based on computer vision to identify body landmarks on real-time video feeds. Several of these important landmarks are the shoulder positions, torso position and the body position. The parameters determine clothing sizes and point of location.

D. Augmented Reality Overlay

The image of processed clothing is also resized and aligned on the basis of identified body landmarks. The system keeps the overlay updated with the user movement so as to offer smooth and realistic visualization.

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E. System Integration
All the parts are combined into a web-based system with the Django framework. The system links with the database to access product information and present its results to the user in real time.

4.2 Algorithm: Virtual Try-On Processing
Step 1: Take video frame with camera.
Step 2: Find body landmarks with pose detection model.
Step 3: Measure shoulder width and body sizes.
Step 4: Resize image of clothing proportionately.
Step 5: Superimpose image of clothing on the user body.
Step 6: Show augmented video.
Step 7: Repeat process for each frame

4.3 Implementation Architecture:
The backend design is based on layered, service-orientated model which facilitates efficient processing of requests and modular system architecture. Client request is sent to the API Gateway where it is sent to the authentication service to validate and permit access securely. Once the user has been authenticated, the business logic layer is used to compute product recommendations and matching algorithms using the user preferences and product data.

The augmented reality (AR) processing unit is in charge of pose detection and rendering to produce real-time virtual try-on images. In the meantime, persistent data, such as user profiles, product information and transaction records, are stored and accessed by the database server. This architecture guarantees scalability, modularity, reliability and secure communication among parts of the system and sustains the real-time performance needed by e-commerce applications of today.

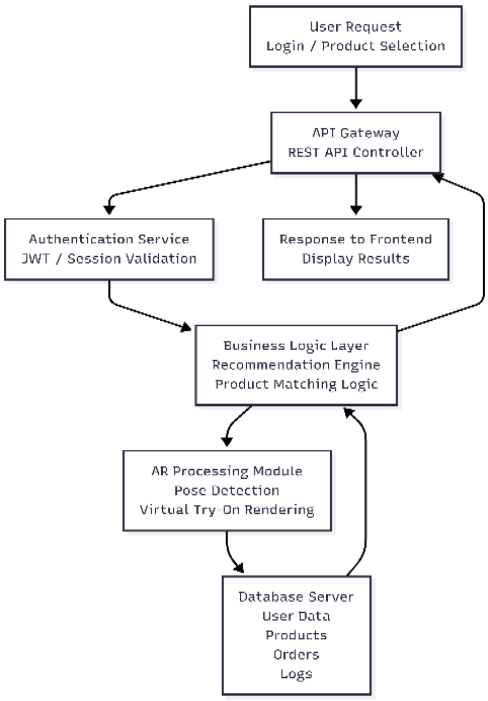


Fig. 2. Detailed backend implementation architecture illustrating request handling, authentication, business logic processing, augmented reality rendering, and database communication.

4.4 Sequence Diagram (User-System Interaction):
The sequence diagram shows how the user, frontend interface, backend server, and database interact step-by-step to complete a normal shopping session. It starts with the user opening the application, and making a request to access

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product information. The request is executed by the backend server which asks the database and replies the corresponding data to the frontend interface to be shown.

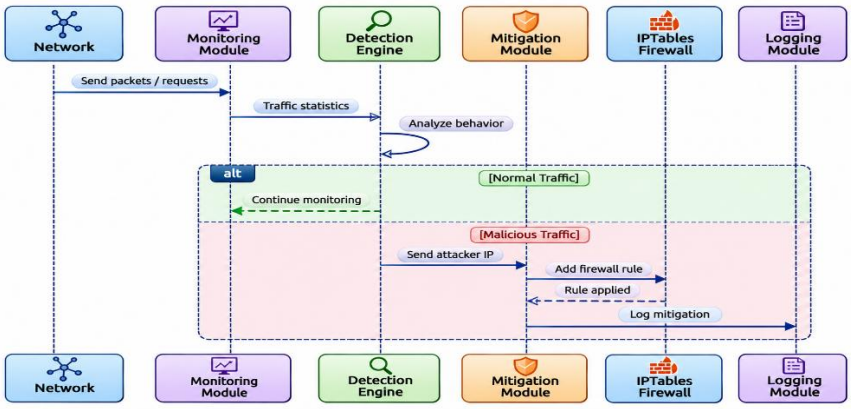


Fig. 3. User–system interaction sequence diagram illustrating the communication between the user, frontend interface, backend server, and database during product selection, virtual try-on processing, and order confirmation.

The AR module does the pose-detection and overlaying the chosen clothing object onto the live video stream of the user in real-time. Lastly, the user is required to verify the purchase, the backend server logs the purchase details in the database and gives an order confirmation response to the user. This chain of interaction guarantees effective communication, real-time processing, and robust management of transactions in the system.

V. RESULTS & DISCUSSIONS

5.1 System Testing Overview

The proposed AR-based virtual try-on system was developed and piloted to assess its functionality, usability, and the accuracy of visualization. The testing was aimed at checking the garment selection interface, virtual try-on, and the fit of clothes on the user interface. To guarantee a normal interactive mode and proper presentation of the augmented reality results, the system was tested under normal operating conditions.

5.2 Product Selection Interface Result

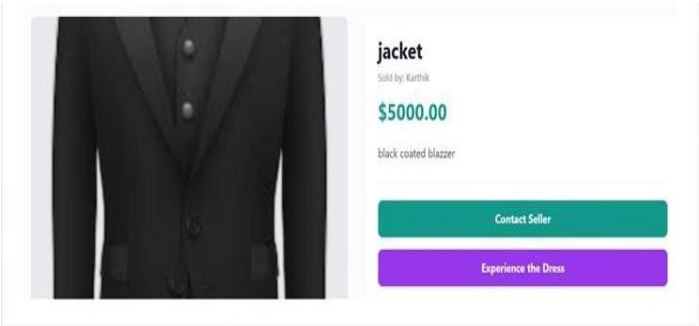


Fig. 5. Product selection interface displaying garment details and the option to initiate the virtual try-on experience.

As Figure 5. demonstrates, the system has a product selection interface, where the user can navigate the items of clothing and see their price and description. The interface has an experience the dress option, which enables users to enable the augmented reality try-on feature.

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5.3 Virtual Try-On Output Result



Fig. 6. AR smart experience display showing the alignment of the selected garment using augmented reality visualization.

This feature allows users to communicate with the system without any difficulties and begin visualization. The proposed system virtual try-on output is illustrated in Figure 6. After the user has made a choice of a garment, the system shows the chosen clothing item in accordance with the display model of the user. The AR visualization gives the idea of putting on the garment, it can be seen by the user, so they can get an idea of the product and then decide to buy it.

5.4 System Performance and Functionality

The system was able to execute the main functionalities of garment selection, visualization, and virtual try-on simulation. The augmented reality component was able to show the chosen piece of clothing on the display interface without major delays. The user experience was responsive to user input, and the try-on experience was real time.
These findings suggest that the given system can offer an interactive and effective virtual shopping experience.

5.5 Performance Comparison Table:

Parameter	Existing System	Proposed System
Visualization Method	Static Images	Real-Time AR Visualization
User Interaction	Limited	Interactive
Clothing Fit Accuracy	Low	High
Image Processing	Manual	Automated
Response Time	Moderate	Fast
Customer Confidence	Low	High
Return Rate	Higher	Reduced
Technology Used	Traditional Web	AI + AR + Computer Vision
Real-Time Detection	Not Available	Available
System Efficiency	Moderate	High

The comparison of the performance provided in Table suggests the benefits of the proposed AI-based augmented reality shopping assistant compared to conventional online shopping systems. Current systems are mostly based on blocky product images, thus limiting the visualization capacities and lowering interaction with users. Conversely, the proposed system will incorporate real-time augmentation reality visualization, so that users can virtually put on clothing through their device cameras.

Automated image processing and pose detection methods considerably enhance the accuracy of clothing fits and the efficiency of the system in general. Moreover, the suggested system offers a quicker response time and improved user interaction due to interactive capabilities. Such enhancements ensure that customers have confidence when making purchases and also aid in reducing the rates of products being returned, which is a typical problem in online fashion retail settings.

Overall, the results of the comparison show that the offered system can be a more progressive and efficient and convenient solution to new e-commerce platforms by successfully integrating AI, computer vision, and augmented

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reality technologies. The system has better visualization precision and real time interaction resulting in greater user satisfaction and lower rates of product returns than traditional web-based shopping systems.

VI. CONCLUSION

This study introduced a design and deployment of an artificial intelligence-based augmented reality smart shopping assistant to improve visualization of clothes online. The system combines computer vision, artificial intelligence, and web development technology to offer a virtual try-on experience that is interactive and enhances decision-making confidence and engagement with the user. The experimental findings indicate that the suggested system is effective in real-time conditions and can minimize the restrictions of the traditional online shopping systems. The automated image processing component will make preparing products easier to the sellers and augmented reality will improve customer satisfaction. The development of work in the future can be aimed at increasing the capabilities of systems to visualize the entire body, model garments in three dimensions and demonstrate personalized recommendation algorithms. These additions will also make digital retail applications more realistic and usable.

VII. FUTURE SCOPE

The proposed AI-driven Augmented Reality Shopping Assistant has provided a solid basis of the intelligent retail applications, but there are a number of improvements that can be considered in the further research and development stages. A possible enhancement would be to introduce deep learning-based object recognition models to serve more product categories, such as accessories, footwear, and home appliances. The next potential direction is the implementation of the cloud-based AR processing to decrease the computational load of mobile equipment and allow large-scale implementation to be implemented on the levels of the enterpriselevel e-commerce solutions. Moreover, a voice-based interface and natural language processing can be used to enhance the usability of users who have less technical knowledge.

Additional personalization capabilities, predictive analytics, real-time emotion recognition, and immersive technologies, including virtual reality (VR) and mixed reality (MR), can be used in the future as well. Such innovations will also increase user interaction, streamline shopping processes and enable the creation of intelligent retail systems of the next generation.

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