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Smart E-Commerce App Using AR to Visualize Products in Real Time On Android

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Abstract
More interactive and immersive product visualization techniques are needed by modern e-commerce platforms to improve user confidence and decision-making when purchasing online. However, static photos and videos are the mainstay of traditional e-commerce applications, which frequently fall short of giving a genuine knowledge of products, resulting in higher return rates and customer discontent. This study suggests a clever e-commerce program that uses Augmented Reality (AR) to show products on Android smartphones in real time. Before making a purchase, customers may accurately visualize a product's size, appearance, and location by utilizing smartphones to view and interact with three-dimensional (3D) replicas of the object in their natural setting. By leveraging AR technology, cloud-based product data, and real-time rendering, the application enhances user engagement, personalization, and shopping experience. While keeping the solution affordable and accessible for customers, it seeks to boost purchase satisfaction, decrease product returns, and promote customer trust. Comparing AR-based e-commerce to traditional e-commerce applications, user feedback and experimental results show that the former greatly enhances product knowledge, user engagement, and overall purchasing efficiency.

Keywords: *Augmented Reality, Smart E-commerce, Product Visualization, AR Core, Android Application, Cloud Database.*

1. Introduction
E-commerce has become a vital aspect of daily life in the current digital era, providing consumers with the ease of making purchases at any time and from any location. The majority of traditional e-commerce systems show products to customers using textual descriptions, static photos, and brief videos. Although these approaches offer fundamental details, they frequently fall short of giving a genuine picture of a product's size, look, and usefulness in actual settings, especially when it comes to categories like furniture, home décor, fashion, and lifestyle items. Accurately envisioning things before making a purchase is difficult for customers, particularly those who shop remotely. Uncertainty, diminished confidence, and misplaced expectations result from the inability to physically scrutinize products. Both customers and online retailers have difficulties as a result of factors like inaccurate size assessment, ambiguous product measurements, and a lack of real-time engagement, which lead to customer discontent and higher product return rates. By superimposing digital content on the real world, augmented reality (AR) has become a powerful tool for overcoming these constraints. Through augmented reality (AR), consumers may interact in real time with three-dimensional (3D) virtual versions of things to see how they might look in their real-world environments. This immersive experience promotes informed decision-making and improves product comprehension. Adoption of AR based e-commerce solutions is both feasible and economical due to the broad availability of smartphones and Android devices with AR capabilities. The goal of this study's smart e-commerce application is to use interactive augmented reality technology to visualize products in real time. The technology enables customers to position, rotate, scale, and examine objects in their surroundings prior to purchase by utilizing AR-Core,

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3D product models, and cloud-based data management. Scalability, real-time updates, and smooth user interaction are further supported by the incorporation of cloud services, which raises system efficiency overall. New avenues for e-commerce application innovation have been made possible by recent developments in mobile computing and visualization technologies. Smartphones with augmented reality (AR) capabilities provide sophisticated shopping experiences without requiring costly gear. Beyond conventional browsing techniques, this technological advancement enables customized, immersive, and self-directed buying. Augmented reality has the ability to revolutionize traditional e-commerce platforms and greatly increase consumer satisfaction, engagement, and trust in making purchases by leveraging these developments.

2. Literature Survey

By bringing immersive and interactive product visualization approaches, recent developments in augmented reality (AR) have drastically changed digital commerce. With AR, users may interact with digital things in real time by superimposing virtual content over the physical world. When compared to conventional image- and text-based shopping platforms, a number of studies have shown that AR-based e-commerce systems enhance customer engagement, product understanding, and purchase confidence. Azuma et al. showed that AR-enhanced visualization aids users in comprehending product dimensions and spatial positioning in real contexts by allowing real-time interaction with three-dimensional (3D) product models [1]. Their research highlighted the importance of visual immersion in lowering ambiguity when making online purchases, especially for items related to furniture and interior design. Poushneh and Vasquez-Parraga also noted that AR buying experiences greatly raise customer happiness and perceived product value [2], underscoring AR's potential to close the gap between in-person and online shopping. The effect of AR on consumer behavior and decision-making has been studied by a number of studies. According to Javornik, AR-based product visualization boosts emotional and user involvement, which in turn raises purchase intention [3]. Similarly, Rese et al. discovered that by enabling customers to see products in their own settings prior to purchase, AR-enabled purchasing systems increase trust and lower perceived risk [4]. These results show how well AR works to improve the entire e-commerce experience. The popularity of smartphones has drawn special attention to mobile-based augmented reality applications. In order to improve usability and lower return rates, Huang and Liao created a mobile augmented reality shopping application that allowed users to preview products in real time [5]. Yim et al. claim that mobile AR shopping systems improve user perceptions of online shops and increase experiential value [6]. These studies emphasize how crucial real-time engagement and mobile accessibility are to AR-enabled e-commerce systems. AR applications for particular product categories have been the subject of numerous studies. Applications for AR fitting rooms have been shown by Kim and Forsythe to increase size accuracy and customer confidence in fashion e-commerce [7]. Hilken et al. also demonstrated that AR visualization tools greatly increase consumer involvement when they browse for furniture and home décor [8]. AR-based e-commerce apps perform better than traditional platforms in terms of user engagement and product comprehension, according to a meta-analysis by Dwivedi et al. [9]. Additionally, it has been demonstrated that AR facilitates personalized and interactive buying experiences. Pantano and Servidio claim that by allowing product modification like rotation, scaling, and placement, AR-enabled e-commerce platforms promote active exploration and boost customer interaction [10]. However, the adoption of many current AR systems is limited in developing regions and small-scale organizations because to their expensive development costs, limited device compatibility, or proprietary hardware. Several researchers have suggested smartphone-based augmented reality e-commerce solutions to address accessibility issues. For Android smartphones, Jiang et al. presented a lightweight AR shopping framework that preserved real-time viewing performance while lowering processing overhead [11]. Cloud-based scalability, real-time product updates, and collaborative features that

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improve user involvement and company efficiency are still lacking in many existing systems, despite these developments. The combination of AR with gesture-based interaction and artificial intelligence (AI) has also been studied recently. Li et al. created an intelligent augmented reality shopping assistant that used AI-driven suggestions to increase user pleasure and personalization [12]. In order to facilitate natural user interaction in augmented reality shopping environments, other studies included gesture detection and real-time feedback methods [13], [14]. These developments show how sophisticated and flexible AR-based e-commerce platforms are becoming more and more capable. High development complexity, restricted scalability, and inadequate integration of cloud-based product management systems are some of the issues that persist despite encouraging outcomes. Additionally, rather than offering a thorough, real-time, and constantly updated buying framework, a large number of current AR e-commerce applications concentrate on discrete visualization elements [15]. Driven by these constraints, the suggested system seeks to create an intelligent, scalable, and engaging augmented reality (AR)-based e-commerce app for Android smartphones. The technology improves accessibility, facilitates on going product changes, and boosts customer engagement by combining AR-Core, cloud-based product databases, and real-time 3D visualization. These characteristics make the suggested method a good way to close the gap between conventional internet buying and engaging in-person product encounters.

3. Methodology

The suggested system aims to deliver an intelligent augmented reality-based e-commerce environment. The approach combines real-time interaction, cloud-based product data, and three-dimensional (3D) product visualization to improve consumers' comprehension of products and facilitate well-informed purchasing decisions. The key elements of the system architecture are an Android mobile application with augmented reality capabilities, a cloud database, and an interaction module that allows for user manipulation and real-time product viewing. Figure 1 shows Methodology of the Proposed AR-based E-Commerce Application

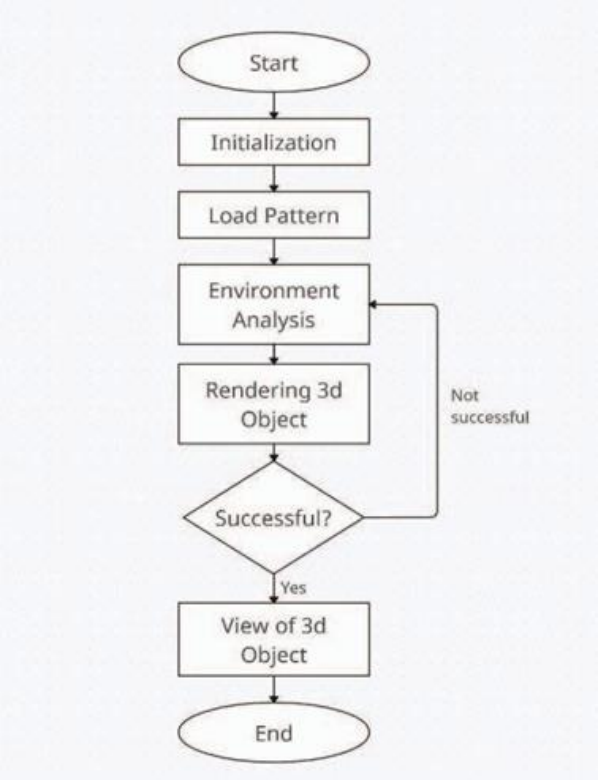

Figure 1 Methodology of the Proposed AR-based E-Commerce Application

The creation of the AR application using Unity 3D combined with AR-Core allows for the real-time rendering and tracking of virtual product models within a physical environment. Product models are dynamically loaded into the program from standardized 3D formats maintained in the system based on user selection. By scanning a flat surface, users can position, rotate, zoom, and interact with virtual objects. The chosen product will then be precisely projected onto the real-world perspective. To guarantee exact alignment between virtual products and the real world, the system makes use of AR Core's plane detection and spatial tracking features. Even when the mobile device is moving, these methods enable the application to recognize horizontal surfaces and keep the 3D product models in a stable position. By adjusting the lighting in the virtual product to match actual conditions, environmental awareness and light estimation features further improve realism. The application

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workflow is intended to be both user-friendly and modular. Following login, users can choose goods for augmented reality depiction via a product browsing interface. After selecting a product, the AR engine starts real-time tracking and renders the matching 3D model. Users may rotate, scale, relocate, and examine the object in detail using intuitive touch-based gestures, making for a seamless and engaging buying experience. Level-of-detail (LOD) control and effective rendering strategies are used to maximize performance on Android devices with different hardware specifications. The system optimizes latency and memory utilization by dynamically loading just the necessary materials during runtime. This method maintains visual quality, guarantees seamless operation, and improves the user experience. The modular design of the system architecture facilitates future growth and scalability. It is possible to incorporate new goods, 3D models, and interactive elements without changing the fundamental framework of the program. This modularity makes maintenance easier and facilitates on going enhancement in response to user input and changing e-commerce needs. Product data, 3D assets, pricing details, and metadata are all managed through an integrated cloud-based database. Product catalogues can be updated instantly with real-time synchronization, which eliminates the need to reinstall applications. To enhance corporate intelligence and customer happiness, user interaction data and preferences can also be safely kept to facilitate analytics, personalization, and future system optimization. Figure 2 shows Augmented reality Market Evaluation

Figure 2 Augmented reality Market Evaluation

The interactive help module of the system offers guided support and contextual product information during shopping sessions. To assist customers in understanding features, dimensions, and usage data, this module shows visual indicators and educational overlays that are in line with the 3D product models. Additionally, the program facilitates shared augmented reality viewing experiences, which improve collaborative decision-making by enabling several users to view and interact with the same virtual product at the same time. User login is the first step in the system's entire workflow. Next come product selection and augmented reality visualization. Users can examine the object in real time, view comprehensive details, and assess its placement or appearance in their surroundings once it has been engaged. The suggested strategy is to increase user confidence, engagement, and product clarity in intelligent e-commerce applications by fusing immersive imagery with cloud-based product data and interactive guidance.

4. Results and Discussion

The usefulness of the suggested augmented reality-based smart e-commerce application in improving the online purchasing experience was assessed through functional testing and user-based observations. The system was tested on augmented reality-capable Android handsets to verify real-time rendering performance, product placement accuracy, and interface responsiveness. The results demonstrate that the application successfully superimposes three-dimensional (3D) product representations onto real-world settings with low latency, resulting in fluid visualization and interaction. Figure 3 shows Application Output and Interaction Results

Figure 3 Application Output and Interaction Results

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Undergraduate participants' user input was gathered in order to assess the entire purchasing experience and usability. Because they could examine and interact with three-dimensional (3D) product models in real time within their own area, most users reported better product understanding. Interactive capabilities like rotation, scaling, and real-time positioning greatly improved product clarity and decision-making confidence as compared to conventional image-based e-commerce systems. Users also thought the system was interesting and easy to use, which made them more involved and satisfied when they were buying. Figure 4 shows Microphone is Shown in the Camera Using AR

Figure 4 Microphone is Shown in the Camera Using AR

Conclusion and Future Work

An interactive augmented reality-based smart e-commerce application was proposed in this study with the goal of improving the online purchasing experience. The suggested method gets around some of the main drawbacks of traditional e-commerce systems that rely on static images and descriptions by offering cloud-based product assistance, real-time engagement, and immersive 3D product visualization. By allowing buyers to examine things in their actual surroundings before making a purchase, the system enhances user engagement, product comprehension, and purchasing confidence. When compared to conventional e-commerce techniques, the AR-based application offers a more efficient and entertaining shopping experience, according to user feedback and trial findings. Because Android devices are so widely available, the solution can be accessed by a wide range of user groups and market segments. The technology is a useful addition that bridges the gap between online and in-store buying, even though it is not meant to completely replace real retail experiences. Future research will concentrate on improving the system by including cutting-edge features like real-time analytics of user activity, artificial intelligence-driven product suggestions, enhanced lighting, and physics-based rendering for greater realism. The usefulness and accessibility of the product catalog will be further enhanced by adding top-notch 3D models and multilingual support. Furthermore, adding wearable augmented reality devices and shared real-time visualization to the platform can greatly improve remote help and cooperative shopping experiences. Adaptive customisation, real-time feedback systems, and intelligent virtual assistants to assist users during the buying process are further ways to enhance the suggested system. Customized product recommendations and higher conversion rates can be achieved by AI-based analysis of user preferences and interactions. The AR-based smart e-commerce platform will become more effective, scalable, and influential in the changing digital commerce ecosystem as a result of these improvements.

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