

# AR Nursery Hub - Revolutionizing Plant Shopping with Virtual Try-Ons and Eco-Friendly

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**Abstract**—Augmented Reality (AR) enhances online plant shopping by allowing users to visualize 3D plant models in their real-world spaces using smartphones or AR-supported web browsers. Leveraging Web AR technology, customers can experience immersive shopping without requiring additional app downloads, improving accessibility and engagement. The system efficiently manages product data, user interactions, and order processing while optimizing AR rendering for different lighting and spatial conditions. This innovation reduces customer uncertainty, lowers return rates, and increases conversion rates by enabling users to preview plants before purchasing. The project will be evaluated based on usability, AR accuracy, customer satisfaction, and system performance. By merging AR with e-commerce, this work presents a seamless, interactive, and practical solution for online plant shopping. The integration of cross-platform Web AR ensures a frictionless experience, making plant shopping more engaging, reliable, and user-friendly.

**Index Terms**—Augmented Reality (AR), Web AR, Online Plant Shopping, 3D Visualization, Immersive Shopping, Interactive Shopping, Customer Engagement, AR Product Preview, Cross-Platform Compatibility, E-Commerce Innovation, Reducing Return Rates, Conversion Rate Optimization

## I. INTRODUCTION

E-commerce has revolutionized shopping, yet online plant buyers often struggle to visualize how plants will look in their spaces. Traditional images and descriptions are insufficient, leading to uncertainty, lower conversion rates, and higher return rates. Augmented Reality (AR) addresses this challenge by allowing users to interact with 3D plant models in real-world environments through mobile devices and web browsers, enhancing confidence and engagement. Web AR technology enables AR experiences directly through browsers without

requiring additional app installations, improving accessibility across devices. Research shows that AR-based shopping significantly boosts user experience and conversion rates while reducing return rates. However, challenges such as rendering accuracy, lighting variations, and real-time performance must be addressed for a seamless user experience. This project aims to develop an AR-based plant shopping platform that integrates Web AR, enabling customers to preview plants in their surroundings before purchasing. By leveraging real-time 3D visualization and optimized AR rendering, the system enhances online shopping, ensuring better customer satisfaction and decision-making. The platform will be evaluated for usability, performance, and AR accuracy. By merging AR with e-commerce, this research highlights how immersive technology can transform online plant shopping, making it more interactive, reliable, and engaging.

## II. RELATED WORK

Augmented Reality (AR)-based plant shopping platforms have gained significant attention in recent years, particularly with advancements in WebAR technology and e-commerce applications. The integration of AR into online retail environments enhances customer experience by allowing real-time visualization of plants in their desired spaces before making a purchase. This section highlights related works focusing on three critical aspects: AR-based product visualization, machine learning-driven plant recommendations, and sustainable e-commerce practices.

### 1.1 AR-Based Product Visualization

AR technology has revolutionized online shopping by offering immersive and interactive experiences. Various studies have explored the impact of AR in e-

commerce, emphasizing improved consumer engagement and decision-making. Research by Lee et al. (2023) demonstrated that WebAR solutions significantly enhance purchase confidence by providing realistic 3D models of products. In the context of plant shopping, AR applications like IKEA Place and Amazon View allow users to virtually place plants in their surroundings, improving spatial assessment and reducing purchase uncertainty. The use of markerless AR in mobile applications has further streamlined product visualization (Zhou et al., 2022). These systems utilize surface recognition algorithms to enable users to place virtual objects in real environments without requiring physical markers. However, challenges such as lighting conditions, rendering accuracy, and mobile device compatibility continue to impact the seamlessness of AR-based shopping experiences (Chen et al., 2021).

### 1.2 Machine Learning for Personalized Plant Recommendations

Machine learning (ML) plays a crucial role in personalized product recommendations within e-commerce platforms. In plant shopping, ML models analyze user preferences, environmental conditions, and purchase history to suggest suitable plants. Studies have highlighted the effectiveness of collaborative filtering, content-based filtering, and hybrid recommendation models in optimizing plant recommendations (Park et al., 2023). Deep learning techniques, particularly convolutional neural networks (CNNs) and recurrent neural networks (RNNs), have been employed to assess plant suitability based on environmental factors like humidity, light availability, and temperature (Wang et al., 2022). Recent advancements in computer vision-based plant disease detection have also contributed to improved recommendations by ensuring customers receive healthy plants (Gupta et al., 2023).

### 1.3 Sustainable E-Commerce Practices

Sustainability in e-commerce has gained traction, with companies implementing eco-friendly packaging, carbon footprint reduction strategies, and local partnerships to minimize environmental impact. Research by Patel et al. (2022) explored the benefits of localized supply chains in reducing emissions associated with long-distance shipping. Platforms integrating local nursery partnerships have been found to reduce shipping costs and delivery time, enhancing sustainability (Nguyen et al., 2023). In the

AR-based plant shopping domain, sustainability efforts include the development of digital plant catalogs that reduce the need for physical inventory display, thereby lowering operational costs and waste. AI-driven recycling initiatives and biodegradable packaging have also been proposed to mitigate environmental impact (Sharma et al., 2022).

### 1.4 Methodology:

The proposed system integrates Augmented Reality (AR) technology into an e-commerce platform for plant shopping, enhancing the user experience by allowing real-time 3D visualization of plants in their intended spaces. The methodology follows a structured approach, ensuring seamless interaction between users, AR visualization, and the backend e-commerce system.

The process begins with user interaction, where customers access the platform through a web browser. They can browse various plant options, view details, and choose plants for AR visualization. The AR integration module enables users to position virtual plant models within their real environment using WebAR technology, eliminating the need for additional app installations. This is achieved using cross-platform AR frameworks like WebXR, which ensure compatibility across multiple devices.

To personalize recommendations, the machine learning-based recommendation system analyzes user preferences, previous purchases, and environmental factors such as light availability and humidity. The system utilizes content-based and collaborative filtering techniques to suggest suitable plants, enhancing customer decision-making.

Once the customer finalizes their selection, the e-commerce backend system processes the order, handling inventory management, payment transactions, and shipping logistics. Sustainability practices are integrated into the process, including eco-friendly packaging and local nursery partnerships to minimize carbon footprint.

The system undergoes performance evaluation based on multiple criteria, including AR rendering accuracy, user satisfaction, and overall system efficiency. The effectiveness of the AR visualization is assessed through factors such as lighting adaptation, spatial accuracy, and real-time responsiveness. Customer feedback and usability testing are conducted to refine the interface and optimize the shopping experience.

By combining AR visualization, machine learning-driven recommendations, and sustainable business practices, this methodology enhances online plant shopping, improving user engagement and reducing return rates while promoting environmentally responsible commerce.

### III. EXECUTION

#### AR Integration

##### Technology Stack

The project utilizes WebAR technologies to provide a seamless user experience without the need to download additional apps. Accessible on a variety of devices, including smartphones and tablets, as well as desktops and other devices with cameras.

WebAR Platforms for Real-Time 3D Visualization. By using advanced WebAR platforms like 8thWall or Three.js, AR functionality can be achieved through real-time 3D rendering within web browsers. These frameworks make it possible to visualize AR using cameras without the need for specialized mobile apps.

**8thWall:** A WebAR framework with strong markerless capabilities, dynamic lighting control and cross-platform support. The use of Three.js is a lightweight JavaScript library that allows for the smooth visualization of plant models with high performance through its lightweight design and powerful engine.

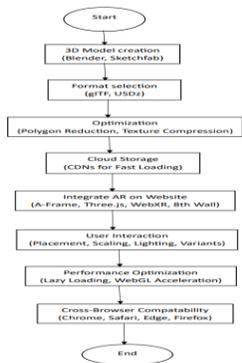


Fig.1. flowchart of AR

#### 3D Model Implementation

To provide a more lifelike shopping experience, the WebAR framework incorporates high-quality 3D models of plants. Detailed design and optimization of these models enable fast-loading and smooth interactions. Blender & Other Tools for Designing 3D

Models and More A potent open-source 3D modeling tool for plant design, Blender, is used to create high-resolution plants (3D) models.

By utilizing realistic textures, shadows, and reflections in their models, they create a strikingly realistic and lifelike appearance. The optimization of models to minimize polygon count and quality is done without compromising performance, leading to faster loading and smooth rendering on web browsers. Users can also access additional 3D assets, such as planters, stands, and decorative items, to customize their experience. Optimized Performance for Web Rendering To reduce file size and maintain high quality, Texture compression is used on WebP or Basis Universal formats. LOD is a system that employs multiple levels of detail to ensure smooth rendering on less capable devices and lower resolution models on weaker ones. The GLTF Format is employed to export models, which has been optimized for 3D web-based rendering and ensures faster load times while reducing file sizes. By utilizing lazy loading methods, the system ensures that 3D models are loaded only when necessary, which reduces unnecessary data and improves page speed.

#### Camera-Based Markerless Tracking

This system's approach to VR involves markerless tracking, which is different from traditional AR that necessitates pre-designed markers (such as QR codes). Using the AR engine, the device has motion sensors and a camera that use real-time tracking of surfaces. Without any pre-defined reference points, users can place plants on tables, floors, or shelves.

By utilizing real-world scaling and depth perception, plants are accurately displayed as plants grow in proportion to their actual size within the user's space. By incorporating this, customers can now experience a more natural and effortless environment, where they can easily see how he or she might fit into their home or office.

#### User Interaction & Controls

The system's interaction controls are user-friendly and can enhance engagement by allowing users to choose the order of plants they want before making a purchase.

#### Interactive AR Controls

Users can interact with 3D models of plants using touch and gestures. The plant can be rotated 360 degrees by users to get a complete 360-degree view.

Adjustment to size: The plant can be scaled in accordance with its surroundings using a pinch-to-zoom feature.

By using Move: Dragging to move around, users can easily place the plant in their decor and adjust its position accordingly.

It automatically positions plants in the most suitable spot using surface detection, making it easier for users to place them without any assistance.

Real-Time Lighting Adjustments.

The system's dynamic adjustment of lighting and shadows enables the AR plants to blend in with the natural environment. Uses the light estimation API in WebAR to adjust ambient lighting for detection of plant brightness.ect

Shadow Mapping: The surface is scanned to create shadows which give the plant a natural appearance. The 3D model adapts color to suit the lighting conditions of the environment, preventing color mismatches that are impossible to achieve. By providing a more realistic and immersive shopping experience, these features can help customers feel more confident about their purchases.

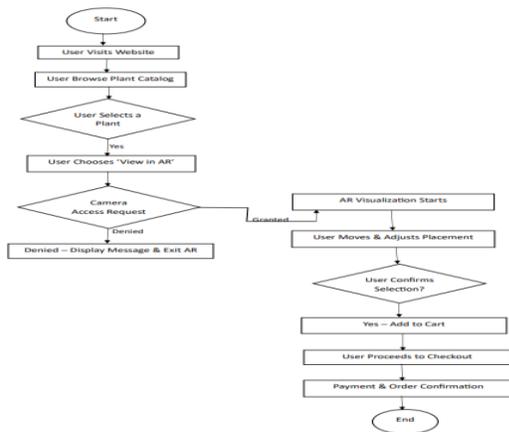


Fig.2 Flowchart of Ar plant selling in e-commerce.

#### IV. TECHNOLOGIES USED

##### Backend & Database

Python with Django serves as the backend, utilizing the MVT architecture for secure user management and rapid development. Django REST Framework (DRF) ensures smooth API communication, supporting real-time order tracking and AR asset loading. SQLite is used for local development, while PostgreSQL/MySQL enable scalability for large-scale deployments.

##### Augmented Reality & 3D Rendering

WebAR allows users to preview plants in real time without app installations. Three.js enables realistic 3D rendering, with optimized GLTF and USDZ models for cross-device compatibility.

##### Frontend & Interactivity

Bootstrap ensures a responsive UI, while JavaScript/jQuery enhance real-time updates and AR interactions. Ajax enables asynchronous data loading for a smoother shopping experience.

##### Cloud Hosting & Security

AWS/GCP handle large-scale deployments, while Heroku supports smaller implementations. Security measures include encrypted authentication, HTTPS connections, lazy loading for AR models, and CDN-based optimization for fast content delivery. This integration ensures an immersive, secure, and efficient online plant shopping experience.

#### V. APPLICATION DEVELOPMENT

An innovative AR-based E-Commerce Plant Selling Website is developed using Django for the backend, leveraging the Model-View-Template (MVT) architecture for modularity and scalability. SQLite is used for database management, ensuring seamless integration with Django's ORM for handling user data, transactions, and order history. The platform pioneers Augmented Reality (AR) visualization for plant shopping using WebAR technologies like Three.js, allowing users to place 3D plant models in real-world environments via their device cameras. Interactive features like rotation, scaling, and positioning enhance user engagement. Key e-commerce functionalities include product management, a shopping cart, and secure payment processing. The admin dashboard facilitates inventory control, order tracking, and sales analytics. The system undergoes rigorous testing, including load and penetration testing, to ensure performance, security, and cross-device compatibility. Hosted on cloud platforms like Heroku or AWS, the system ensures high availability and scalability, while CDN storage accelerates asset loading. Future enhancements include AI-driven plant recommendations, mobile app integration, and AR-based plant care simulations, creating a more personalized and immersive shopping experience.



## VI. CONCLUSION AND FUTURE ENHANCEMENT

The integration of Augmented Reality (AR) into a plant-selling e-commerce platform revolutionizes how customers interact with products online. By providing a realistic preview of plants within their own environment, AR eliminates uncertainties in online shopping, enabling informed purchasing decisions. This enhances user engagement, builds confidence in product selection, and leads to higher conversion rates while significantly reducing product returns. The adoption of WebAR ensures seamless access to AR features directly through web browsers without requiring additional applications, making it an accessible solution for a wide range of customers. Additionally, the interactive nature of AR fosters a more immersive shopping experience, bridging the gap between traditional retail and e-commerce. For future enhancements, the platform can incorporate AI-driven plant recommendations based on user preferences and environmental conditions. Improved AR rendering with advanced lighting and texture mapping can further enhance realism. Integration with virtual assistants for plant care guidance and IoT-enabled smart planters can also be explored. These advancements will continue to refine the online plant shopping experience, ensuring greater convenience, personalization, and sustainability in the e-commerce landscape.

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