PlaceIt!

Project Description Document

1. Project Overview

- **Name of the Project:** PlaceIt!
- **Brief Description:** a web-based open marketplace platform that connects furniture sellers and buyers through an interactive 3D and Augmented Reality (AR) experience. Sellers can register to list their furniture by uploading descriptive details and optionally a video of the item, which is used to generate a photorealistic 3D model. The platform enables sellers to manage their inventory, update listings, and track sales activity through a personalized dashboard.

  On the buyer side, users can search for furniture, explore item details, and—when a 3D model is available—interact with the furniture in real time via AR. Using their device's camera, users can visualize how the item would look in their environment, move and rotate the object, and finalize their purchase—all within the same intuitive interface.

  This seamless integration of 3D modeling and AR visualization aims to enhance buyer confidence and engagement while offering vendors a modern channel for immersive product presentation.

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2. Key Features

Seller Registration & Management Dashboard

- Dedicated portal for sellers to register and manage their accounts.
- Dashboard functionalities include:
  - Uploading and editing product listings.
  - Uploading a product video for automated 3D model generation.
  - Tracking sales history and performance analytics.
  - Managing inventory and active listings.

Furniture Browsing & Search with Filters

- Users can search and browse furniture listings using customizable filters:
    - Category (e.g., sofa, table, bed)
    - Color, style, price range, and material
    - Availability of 3D/AR view

Automated 3D Model Generation

- Sellers can upload a product video from which the system generates a 3D model
- Optimized mesh and texture generation with backend processing pipeline.

3D Model Preview

- Users can interact with 3D furniture models in a browser-based viewer.
- Model interaction includes: Zoom, rotate, and pan

Augmented Reality (AR) Visualization

- If a 3D model is available, users can:
    - Activate their device's **mobile camera**. (Note: Furniture AR placement with camera will primarily be supported on phones as WebXR AR capabilities are generally better supported on mobile devices compared to laptop cameras).
    - Place the 3D model in their real-world environment.
    - Move, rotate, and scale the object in real time using intuitive touch or pointer gestures. (Note: Phone users will get the full AR experience, while unsupported devices will get a fallback 3D model viewing page just for viewing, not AR.)

Cart Management & Checkout

- Add furniture to the cart directly from the listing or AR preview pages.
- Modify quantity or remove items from the cart.

User Authentication and Account Management

- Support for different roles: vendors and clients.
- Secure login, registration, and session management.
- User profile pages with purchase history and preferences.

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3. User Journey / Flow

Vendor Journey

1. The vendor accesses the PlaceIt! web application and registers for an account as a seller.
2. Upon successful login, the vendor is directed to their personalized dashboard.
3. From the dashboard, the vendor can create new product listings by entering furniture details (name, dimensions, material, price, etc.).
4. As part of the listing process, the vendor can optionally upload a video of the furniture item.
5. The backend system processes the video and automatically generates a 3D model using photogrammetry techniques.
6. The vendor can preview the generated model and confirm or edit the listing.
7. Once published, the product becomes visible in the public marketplace.
8. Vendors can return to the dashboard to update listings, monitor product views, and track sales performance.

Client (End User) Journey

1. The client accesses the PlaceIt! web application without needing an account to begin browsing.
2. The client uses filters (e.g., category, material, price range) to search and explore furniture listings.
3. Upon selecting a product, the client is presented with detailed information, including images and specifications.
4. If a 3D model is available, the client can interact with it directly in the browser using zoom, rotation, and panning.
5. Additionally, the client can activate the AR mode using their device's webcam or camera to visualize the item in their own physical space. Real-time interaction allows for moving, rotating, and scaling the virtual furniture.
6. Satisfied users can add products to their cart.
7. When ready to purchase, the user is prompted to register or log in to complete checkout.
8. The client proceeds to payment, confirms the order, and receives a confirmation of the transaction.
9. Registered users can also access a personal dashboard to view order history and manage account settings.

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4. Tech Stack

Frontend

- **Framework:** React.js
- **Libraries:** Three.js, A-Frame.js (for 3D model viewing), WebXR.js (for AR functionality)
- **Styling:** Tailwind CSS

Backend

- **Framework & Language:** Node.js with Express.js
- **Database:** Supabase (PostgreSQL-based backend as a service)

- **Storage:** Supabase Storage (for videos, 3D models, and images)
- **3D Processing Tools:** COLMAP + OpenMVS (for mesh reconstruction from uploaded videos)

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5. Frontend Architecture

Global Structure

- **Layout Components:**
    - **Header:** Fixed top bar with logo, navigation links (Marketplace, Upload, Dashboard), and user account access (login/register/profile).
    - **Footer:** Basic footer with contact info, terms of service, and links to social media or support.
- **Routing Strategy:**
    - React Router will be used for handling page navigation without full reloads.
    - Role-based routing to distinguish between vendor and client views.
    - Lazy loading for AR pages and model viewer to optimize performance.

Pages & UI Components

1. Landing Page

- Publicly accessible main entry point.
- Sections include:
    - Hero Banner: Animations and messaging emphasizing AR furniture placement and 3D visualization.
    - Call to Action Buttons:
        - *Register Now*
        - *Explore Marketplace* (guest access allowed)
        - *Become a Vendor*

- Quick overview of the platform's advantages over standard marketplaces.
- Animated or interactive demo (embedded 3D model or AR teaser).

2. Sign-Up / Login Page

- Standard email/password auth with role selection.
- Optional social login integration (Google, etc.).
- Redirects to role-specific dashboards after successful login.

3. Marketplace / Product Listing Page

- Accessible to both guests and registered users.
- Components:
  - Search Bar
  - Category & Filter Sidebar: Price, style, color, size, 3D model availability
  - Product Grid View: Each item shows an image preview, price, short description, and tags like "View in 3D" or "AR Available"
  - Infinite scroll or pagination

4. Product Detail Page

- Displays detailed furniture info: description, dimensions, materials, price, etc.
- Tabs or sections for:
  - Image Gallery
  - 3D Viewer (if available): Built with Three.js + A-Frame.js
  - AR Mode Launch Button: Triggers WebXR.js experience via user camera
  - Add to Cart and Wishlist

5. AR Experience Page

- Launches camera overlay using WebXR.js.
- Loads 3D model in scene; allows:

    - Move, rotate, and scale objects using touch. (Note: This AR experience and furniture placement with the camera will primarily be supported on mobile devices/phones. Laptop cameras may not fully support WebXR AR capabilities).
    - Confirm placement
- Fallback message if device or browser doesn't support WebXR.js (Note: Unsupported devices will get a fallback 3D model viewing page just for viewing, not AR).

6. Vendor Dashboard

- Role-restricted view for vendors.
- Features:
    - Upload Product Page: Form for entering details + upload video for 3D reconstruction
    - Product Manager: Edit, unpublish, or delete listings
    - Sales Overview: Revenue, order status, top-performing items
    - Notifications on model generation status or customer inquiries

7. Client Account Page

- View order history, saved items, and AR interactions
- Manage personal details and preferences
- Access to support or contact form

8. Cart & Checkout

- Standard checkout page

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6. Backend Architecture

Responsibilities

1. **User Authentication & Authorization**
   Handles secure registration, login, and role-based access (vendor vs. client), using Supabase's built-in auth system with JWT tokens.

2. **3D Model Processing Pipeline**
   Manages the ingestion of uploaded furniture videos from vendors, triggers a processing pipeline (COLMAP + OpenMVS) to generate 3D meshes, and stores results in Supabase.

3. **Product & Vendor Management**
   Allows vendors to create, update, and delete furniture listings. Each listing includes metadata, images, video, and references to generated 3D models.

4. **Marketplace API**
   Serves product data to the frontend, supporting filtering, pagination, and category-based browsing. Allows public access for guests with restricted data.

5. **Cart & Order Handling**
   Manages shopping cart state, order creation, and payment initiation. Associates orders with user accounts and provides order history for clients.

6. **AR Model Delivery**
   Serves optimized 3D assets in a performant format to the AR frontend (e.g., glTF/GLB), ensuring fast loading during AR visualization.

7. **Storage and Asset Access Control**
   Controls access to user-uploaded videos and generated assets stored in Supabase, ensuring files are secure and only accessible via signed URLs.

8. **Notifications & Status Updates**
   Notifies vendors about the status of their 3D model generation (e.g., pending, failed, completed) via polling or real-time updates (optional).

How It Works – Simplified Flow

1. **User actions** (e.g., sign up, upload product) are sent from the frontend to backend API routes managed by Express.js.

2. **Videos** uploaded by vendors are stored in Supabase Storage and queued for 3D processing.

3. **A processing worker** (server-side script or external server) runs COLMAP + OpenMVS to convert videos to 3D meshes.

4. **Processed 3D models** are uploaded back to Supabase and linked to the product record in the database.

5. **Frontend clients** query the API for product listings or specific items; if a model is available, a URL to data in Supabase is served for rendering or AR use.

6. **Clients can interact** with the model (via Three.js or WebXR.js), add items to cart, and place orders.

7. **Checkout triggers** order creation and potential integration with a payment service.

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7. Database Schema / Data Models

ONLY FOR REFERENCE PURPOSES, REAL TABLES STRUCTURE MAY BE DIFFERENT

1. Users Table

Stores user account data with roles (vendor or client).

Column	Type	Description
id	UUID (PK)	Unique user ID (linked to Supabase auth)
email	Text	User email address
role	Enum	'vendor' or 'client'
name	Text	Full name
created_at	Timestamp	Registration date
profile_image	Text (URL)	Optional link to avatar

2. Furniture Table

Store furniture listings created by vendors.

Column	Type	Description

id	UUID (PK)	Unique ID for the furniture item
vendor_id	UUID (FK)	References `users.id`
title	Text	Name/title of the item
description	Text	Long description
price	Decimal	Listing price
category	Text	e.g., chair, table, sofa
dimensions	JSONB	Object with height, width, depth
tags	Text[]	Search tags
has_3d_model	Boolean	Flag for whether a 3D model is available
status	Enum	'active', 'archived', 'draft'
created_at	Timestamp	Time of creation

3. Media Assets Table

Tracks uploaded videos, images, and 3D model links.

Column	Type	Description
id	UUID (PK)	Unique asset ID
furniture_id	UUID (FK)	References `furniture.id`
type	Enum	'image', 'video', 'model_3d'
url	Text	Supabase storage URL
thumbnail_url	Text	Preview image (optional)
format	Text	File format (e.g., glb, jpg)
created_at	Timestamp	Upload timestamp

4. Model Generation Jobs Table

Handles 3D processing workflow state.

Column	Type	Description
id	UUID (PK)	Job ID
furniture_id	UUID (FK)	References `furniture.id`
video_url	Text	Input video location
output_model_url	Text	Link to generated 3D model (if complete)
status	Enum	'pending', 'processing', 'failed', 'completed'
error_message	Text	Optional processing error log
created_at	Timestamp	Job start time
updated_at	Timestamp	Last status update

5. Cart Table (Optional — ephemeral state can be in frontend, or persisted here)

Column	Type	Description
id	UUID (PK)	Cart ID
user_id	UUID (FK)	References `users.id`
item_ids	UUID[]	References list of `furniture.id`
updated_at	Timestamp	Last modified

6. Orders Table (Optional)

Column	Type	Description
id	UUID (PK)	Order ID

user_id	UUID (FK)	References `users.id`
furniture_ids	UUID[]	Purchased items
total_amount	Decimal	Order total
status	Enum	'pending', 'paid', 'cancelled'
created_at	Timestamp	Purchase date

7. AR Interactions Log Table (Optional — for analytics)

Column	Type	Description
id	UUID (PK)	Log entry ID
user_id	UUID (FK)	References `users.id`
furniture_id	UUID (FK)	References `furniture.id`
duration_seconds	Integer	Time spent in AR mode
interaction_type	Text	e.g., 'move', 'rotate', 'scale'
timestamp	Timestamp	Logged time

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8. AR System Details

Chosen AR Approach

- *PlaceIt!* uses **WebXR.js** built on top of **A-Frame.js** for in-browser markerless augmented reality (via location-based or WebXR.js support).

- This solution enables real-time AR rendering directly within **mobile** browsers. (Note: WebXR AR capabilities are better supported on mobile devices. Therefore, the full AR experience with furniture placement using the camera will be primarily available to phone users. Laptop cameras might have limitations.)

Real-Time Interaction Logic

- After activating AR mode:
    - The 3D model is rendered in camera view over the real-world background. (Note: This is with mobile device cameras, as laptop camera support for WebXR may be limited.)
    - Users can:
        - **Move** the model on the ground plane using gestures or a mouse.
        - **Rotate** it around the vertical axis.Based on the document provided, here's the breakdown of the requested sections with the specifications regarding AR support:
        - (Note: These interactions for furniture AR placement with the camera are fully supported on phones. Unsupported devices will get a fallback 3D model viewing page just for viewing, not AR).

2. Key Features:

- 📷 **Augmented Reality (AR) Visualization**
    - If a 3D model is available, users can:
        - Activate their device's **mobile camera**. (Note: Furniture AR placement with camera will primarily be supported on phones as WebXR AR capabilities are generally better supported on mobile devices compared to laptop cameras).
        - Place the 3D model in their real-world environment.
        - Move, rotate, and scale the object in real time using intuitive touch or pointer gestures. (Note: Phone users will get the full AR experience, while unsupported devices will get a fallback 3D model viewing page just for viewing, not AR.)