Modern Luxury Villa - VR Project Report

1. Design Choices

The villa was designed as a single-story modern structure measuring 20m wide by 14m deep with 5m high walls and a flat dark roof. This footprint was chosen to allow enough interior space for four clearly separated functional zones: a living room, kitchen, bedroom, and bathroom.

The living room is positioned at the center front of the villa, providing immediate visual access upon entry. A wall-mounted television is placed on the front wall, with the sofa set arranged to face it directly so all seating positions have an unobstructed view. A coffee table sits between the sofa and the TV.

The kitchen occupies the left wing and was designed with a realistic appliance layout: a long counter along the back wall, a stove with range hood, sink, fridge, microwave, kettle, and a central island with bar stools. This arrangement reflects a practical working kitchen flow.

The bedroom is placed in the right wing with a double bed, bedside shelves, a floor lamp, and a wardrobe. The wardrobe was rotated so that its front face opens toward the bed, which is the natural and functional orientation.

The bathroom and washroom share a space in the left rear of the villa but are separated by a partition wall. The shower area has a glass screen panel and a shower head, while the toilet and vanity occupy the other side. This partition makes the two zones clearly distinguishable.

Outside, a swimming pool with a raised concrete basin is positioned in front of the villa. The pool features animated water, white coping edges, and two chrome ladders at the front corners. Pool lounge chairs are placed on either side. A garage to the right of the villa houses a red car. Two animated pets, a dog and a cat, are placed on the surrounding lawn away from the pool area.

2. Technical Challenges Faced and How They Were Addressed

The most persistent challenge was achieving a convincing water effect for the pool. Early attempts used a custom A-Frame component registered in the HTML head section before A-Frame itself had loaded, which caused the component to silently fail every time. The water appeared as a flat grey or silver surface with no motion. This was resolved by removing the custom script entirely and replacing it with A-Frame's built-in animation component applied directly on the water plane elements, animating the Y-axis position to produce a smooth bobbing effect. Blue emissive material properties were also added so the water colour is self-lit and cannot be washed out by scene lighting.

A second challenge was the pool appearing as a flat raised floor rather than a real pool. The original pool structure was almost entirely below ground level, so the walls were invisible from the camera. The entire pool was rebuilt with its basin raised above the ground plane, making all four concrete walls clearly visible, with the water sitting visibly inside below the coping caps.

Scene lighting caused colours to appear washed out. An ambient light with intensity 0.9 combined with a point light of intensity 1.8 was bleaching materials to near-white. The ambient intensity was reduced to 0.5 and the overpowering point light was removed, which allowed all surface colours to render accurately.

The outdoor floor surrounding the pool and the front courtyard were rendering as bright white despite having colour values set on them. This was caused by relying on texture asset references that had not yet loaded, causing the renderer to fall back to a near-white default. The fix was to apply solid colour values directly on the material component rather than depending on texture loading.

The television in the living room was initially invisible because the screen was an A-Frame plane element without a rotation, causing it to face upward rather than toward the viewer. Setting rotation to 0 180 0 on the screen plane corrected its orientation. The sofa set also had to be rotated 180 degrees and repositioned so that all seats face the television rather than away from it.

3. Future Improvements

The water effect could be improved further by using a shader-based approach with a normal map texture to simulate realistic light refraction and surface ripples rather than simple plane translation.

Interior rooms could benefit from proper door geometry with open and close interaction, allowing the user to navigate between rooms naturally rather than walking through walls.

Realistic shadow casting between objects would greatly improve the scene depth. Currently only basic shadow receive and cast flags are used without fine-tuned shadow map resolution.

The kitchen appliances are represented by simple geometric shapes. Replacing them with proper 3D models loaded via the A-Frame OBJ or GLTF loader would make the kitchen significantly more realistic.

A day and night cycle could be added by animating the sky texture and adjusting light intensities over time, giving the scene a more dynamic and immersive atmosphere.