AI and WebXR Technologies for Interactive Virtual Tours based on 360-degree capture: The Doha Design District Case Study

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Abstract

We present an industrial use case demonstrating the exploitation of AI-based digital twin technologies developed in the AIN2 project for the creation of immersive virtual tour experiences. The case study focuses on the *Bluu Casa* showroom located in the Doha Design District (DDD). We demonstrate the complete pipeline from single-shot acquisition with a consumer-grade 360° camera to immersive WebXR deployment on head-mounted displays (HMDs) like Meta Quest 3. The proposed solution enables intuitive and photorealistic exploration of interior environments with stereo 3DOF navigation.

CCS Concepts

• **Computing methodologies** → **Graphics systems and interfaces**; **Scene understanding**; **Neural networks**; • **Human-centered computing** → **Virtual reality**; **Web-based interaction**.

Keywords

Panoramic Indoor Scenes, Virtual Tours, WebXR, Immersive systems, Novel View Synthesis

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1 Introduction and Background

Digital twins of indoor environments are increasingly employed across architecture, construction, and real estate. AIN2—Artificial Intelligence for INdoor Digital Twins—is a QNRF-funded project aiming to advance this field by automating the creation and editing of structured models and immersive experiences from sparse panoramic input.

AIN2 focuses on:

- Enhancing panoramic images with semantic and geometric information [Pintore et al. 2024a; Shah et al. 2024b].
- Extracting 3D layouts of complex rooms using AI-driven methods [Gobbetti et al. 2024].
- Enabling photorealistic editing and style transfer via structured visual models [Tukur et al. 2023].
- Supporting immersive and web-based exploration using MCOP (Multiple Center of Projection) representations [Pintore et al. 2024b].

DDD, the Doha Design District, is an innovation hub for the creative and design industries in Qatar. It aims to integrate cutting-edge digital experiences into its physical infrastructure, supporting digital storytelling for curated interior spaces such as the *Bluu Casa* showroom.
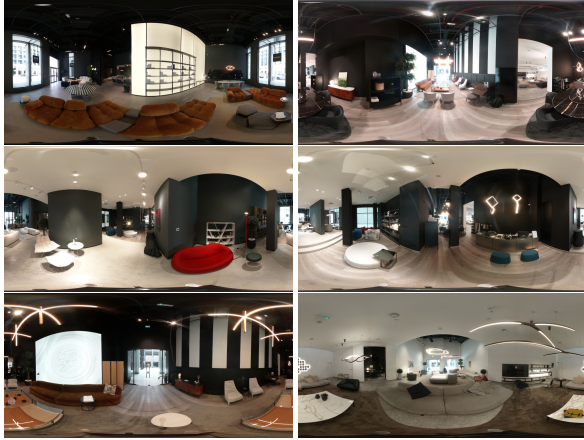
Figure 1: Bluu Casa acquisition. We used two omnidirectional cameras for acquiring sparse shots inside Bluu Casa showroom. In this figure some examples of the panoramic images acquired.
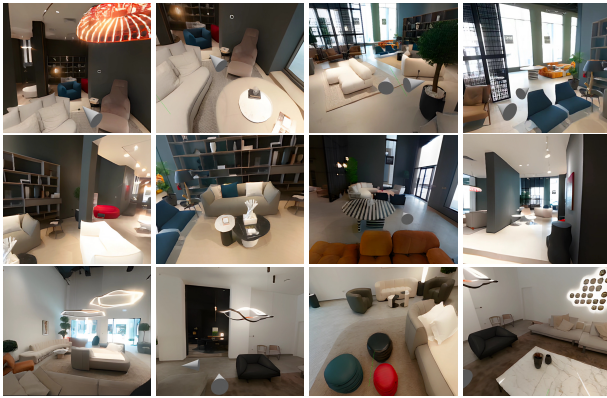

Figure 2: Bluu Casa Virtual Tour. We show frames from interactive sessions with our prototype immersive system. Casual users can experience natural stereo parallax as they explore the showroom virtually. See https://bit.ly/4ksetkZ for a full video.

2 Use Case: Bluu Casa Virtual Tour

The use case presented here demonstrates the deployment of AIN2 technologies for a compelling immersive experience in the Bluu Casa showroom at DDD. The process involved:

(1) **Panoramic Capture**: A minimal set of registered panoramic images was acquired using Ricoh Theta and Insta360 cameras. Each image provides full 360° coverage from a single position, with minimal overlap between shots. Figure 1 shows some of the panoramic shots acquired in the showroom.

(2) **MCOP Stereo Generation**: The captured images were processed using the *PanoStereo* pipeline [Jashari et al. 2024; Pintore et al. 2024b], which synthesizes stereoscopic omnidirectional views from monocular RGB-D inputs, creating 3DOF exploration points.

(3) **Immersive WebXR System**: The MCOP nodes were connected into a navigable graph. Cone-shaped interactive pointers indicate possible transitions to neighboring viewpoints. The system was implemented using WebXR and is compatible with devices like Meta Quest 3 [Tukur et al. 2024].

Casual users experience natural stereo parallax and transitions as they explore the showroom virtually. Figure 2 shows frames acquired from immersive exploration with a Meta Quest 3. The demo prototype can be accessed at https://ddd-mu5u.onrender.com while a full video showcasing examples of immersive exploration of the showroom is available at https://bit.ly/4ksetkZ.

3 Impact and Future Directions

This case validates the effectiveness of AIN2 methods in real-world deployments. The combination of AI-based reconstruction and immersive rendering achieves:

- Reduced manual effort in creating virtual tours.
- High-quality 3DOF navigation with minimal capture data.
- Accessibility via web and mobile VR platforms.

Future developments include integrating semantic-aware style customization [Tukur et al. 2023], furniture recoloring [Shah et al. 2024a], and interactive annotations for enhanced user engagement in retail and real estate contexts.

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