An AR-Guided System for Fast Image-Based Modeling of Indoor Scenes

Daniel Andersen and Voicu Popescu, Purdue University

We propose an Image-Based Modeling and Rendering (IBMR) system that allows a novice user to acquire a large indoor space in minutes, in support of interactive photorealistic visualization. During acquisition, an AR interface guides the user to capture sufficient images efficiently. During rendering, a VR interface guides the user to maximize visualization fidelity.

**Pipeline**

- **AR-Guided Acquisition**
- Acquisition Output: Panoramic frames, Estimated poses, Rough geometry
- **Panorama Selection and Pose Refinement**
- **Morphing Mesh Construction**
- **Guided VR Visualization**

**AR-Guided Acquisition**

- Figure 1: The user walks through the scene while wearing an AR HMD enhanced with a panoramic video camera.
- Figure 2: The AR interface shows a 2D grid of a dynamically generated floor plan, which appears as a map floating in front of the user.
- Figure 3: Unexplored (black) and explored (green) regions, floor obstacles (white), and the user's viewpoint (yellow). Grid cell size = 0.5m.

**Panorama Selection**

- Figure 4: Panoramas (red circles) selected based on estimated AR HMD poses by proximity to traversed grid cell centers and by low rotational velocity. Panorama triplets (gray triangles) defined by Delaunay triangulation.

**Pose Refinement**

- Figure 5: Feature matches between adjacent panoramas, after RANSAC outlier removal, used in bundle adjustment to refine estimated panorama poses are refined via bundle adjustment with pairwise matches.

**Morphing Mesh Construction**

- Figure 6: Third-person view of morphing mesh for a single panorama triplet. For each triplet, the set of common feature matches is expanded with 3D surface samples extracted from the rough geometry captured during acquisition.

**Real-time VR Visualization**

- Figure 7: Image-based rendering of acquired scene. Top row: VR visualization at acquisition location. Bottom row: VR visualization between acquisition locations.
- Figure 8: Left: VR map to guide user (red dot) to nearby panoramas (green dots), for highest fidelity. Right: VR map as seen by user.