LCC Scanning Guide v9.0

Updates

v9.0

1. Added instructions on PortalCam HD Enhancement.

v8.0

1. Added instructions on PortalCam Map Fusion and Aerial-Ground Map Fusion.

v7.0

1. Added instructions on PortalCam's new Portrait Mode and guidance on close-range high-resolution scanning.
2. Updated PortalCam images for improved instructions.

v6.0

1. Added PortalCam scanning guidance.
2. Added Aerial Reconstruction and Spatial Recognition guidance for LCC for Revit plugin.
3. Added reconstruction area and GSD experience indicator tables for Aerial-Ground Map Fusion and Aerial Reconstruction.
4. Revised Map Fusion and Aerial-Ground Map Fusion descriptions.
5. Removed Lixel L1/L2 collection instructions (LCC Studio v1.8.1+ no longer supports L1; v1.9.0+ no longer supports L2).

v5.0

1. Added guidance for HD Enhancement
2. Revised Aerial-Ground Map Fusion scanning guidance with updated takeoff/landing illustrations and areas to avoid
3. Removed Map Fusion and Aerial-Ground Map Fusion scale limitations (these are documented in LCC Studio product documentation)

v4.0

1. Revised the scanning guidance for map fusion function, illustrating the way to avoid cases where two scans completely overlap.
2. Update the scanning guidance for Aerial-Ground Map Fusion.
3. Added guidance and suggestions for using K1 to scan large loop scenarios. See Article 4 of Lixel K1 Scanning.
4. Replaced the diagram of "zigzag walking".

v3.0

1. Add scanning guidance for map fusion.
2. Revised the description of the initial camera rendering position during RTK acquisition in the initialization section.

v2.1

1. Add Lixel L2Pro scanning guidance.
2. Revised the issue of inconsistent depiction of Lixel K1's tilt angle.

v2.0

1. Added Lixel K1 acquisition guidance.
2. Sort out the collection guide framework and divide the parts that are irrelevant to the equipment and related to the equipment.
3. Emphasized the issue of lens dirt.
4. Emphasized the collection problems of corridors, narrow spaces, and entrances and exits of rooms.

v1.2

1. Modification: Manual exposure is no longer recommended as a basic setting for Insta360 camera. Manual exposure is now provided as an advanced setting separately organized and provided in the "Exposure" guide section.

v1.1

1. Modification: 360 Auto Exposure parameter is no longer recommended. Adopt **manual mode fixed ISO + shutter auto** . Add ISO setting guide.
2. Add: Emphasize avoiding rapid **rotation, shaking**.
3. Add: In Orientation Description, add collection examples for different types of **focus objects** .
4. Added: **Initialization** location suggestion.

5. Add/Modify: Extensive GIF explanations.
6. Modify: Other text descriptions.

General Guidelines

Equipment Preparation

- **Clean lenses thoroughly** before each scan - this is critical for quality results.





Movement Fundamentals

- **Maintain steady movement** - avoid rapid rotations, shaking or swinging motions when scanning indoors or at close range.

Motions to avoid:



Rapid rotation



Shaking and swishing

Use gentle turning with appropriate radius, especially in low light



Turn slowly

Personnel should not follow the operator in the scan path too closely or for a long time.

Device-Specific Instructions

PortalCam Scanning

To ensure reconstruction quality, PortalCam scanning involves two phases: overall environment scanning and local HD scanning.

1. Scene Scanning (Overall Environment)

Objective: Ensure complete scene coverage

- **Multi-height trajectories**: Scan at low, chest-level, and overhead positions for complete coverage
- **Device orientation**: Maintain front alignment with movement direction
- **Bidirectional coverage**: Perform forward and reverse scanning on the same trajectory for complete coverage



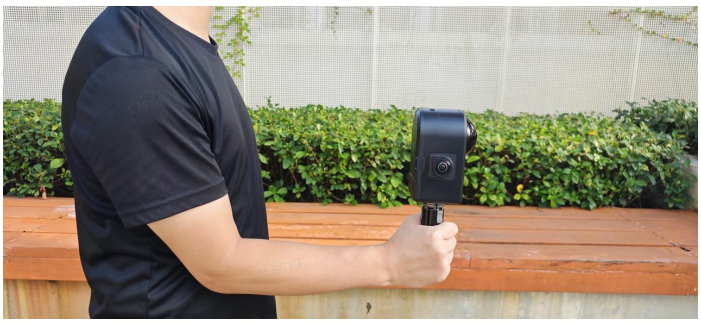
Overhead



Chest height



Low



PortalCam bidirectional coverage - forward



PortalCam bidirectional coverage - reverse

2. High-Resolution Scanning (Local Detail Capture)

Objective: Capture specific targets with clarity, with the front camera directly facing subjects.

- **Multi-angle Coverage**: Reference the "Object Focus" section for capture techniques
- **Live Confirmation**: Use LCC GO to verify image clarity during HD scanning

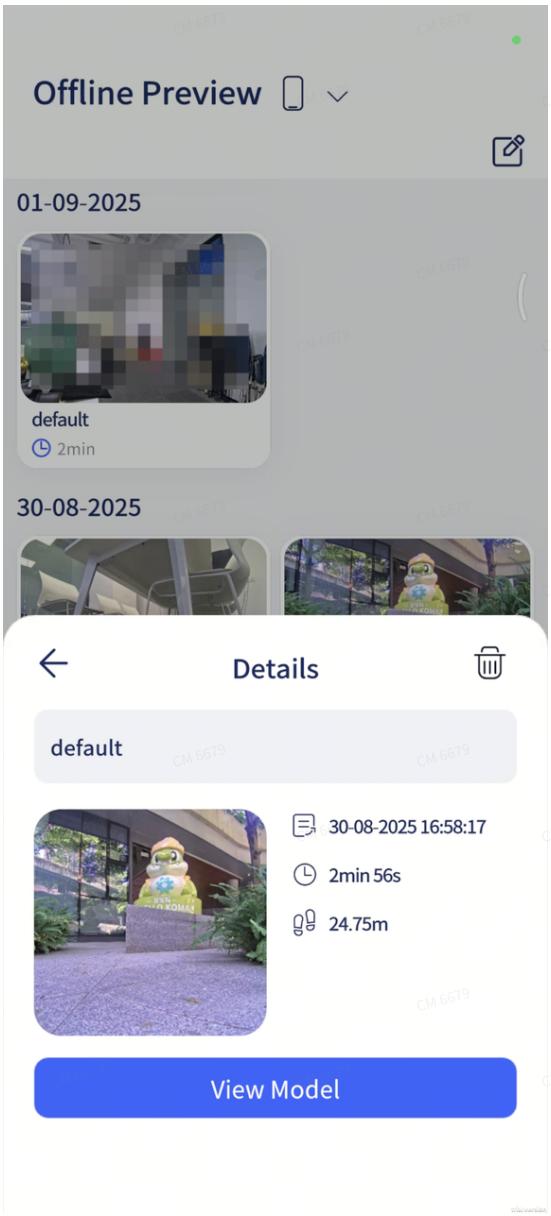


3. Issue Monitoring and Troubleshooting

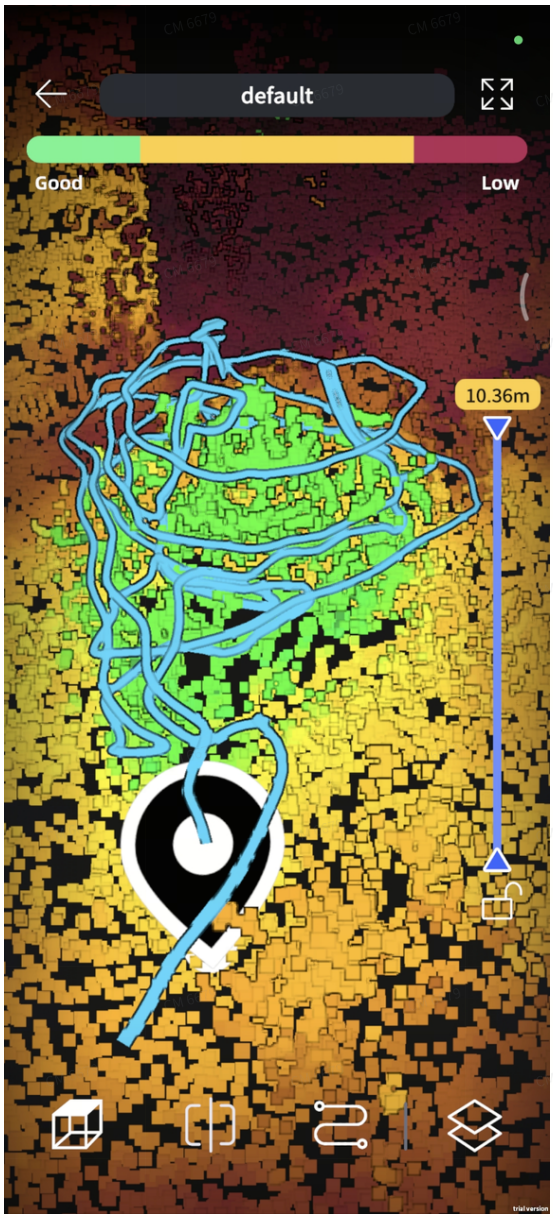
Monitor **LCC Scan** for real-time alerts during capture:

- Initialization failure
- Capture anomalies
- Low battery / memory overflow
- Posture errors / speed violations

Address issues immediately in the field to prevent reconstruction quality degradation.



LCC Scan preview



PortalCam data quality preview

Lixel K1 Scanning

Firmware Verification:

- Ensure the K1 firmware version is 1.2.0 or higher (K1 firmware ⩾ 1.2.0).

1. **Verify firmware versions** - ensure K1 firmware ⩾1.2.0 Ensure that the K1 firmware version is > = 1.2.0.

Scanning Angle:

- During scanning, tilt the scanner downwards at a 15-20 degree angle relative to your walking direction. This allows the LiDAR to effectively scan the ground approximately 5 meters ahead.

2. During the scanning, it is necessary to ensure that the scanner **tilts down 15-20 degrees** along the walking direction, so that LiDAR can scan the ground about 5m in front of the walking direction.





3. **Lens Orientation:**

- **Open Areas:** Hold the scanner with one lens facing left and one facing right relative to your walking direction. The circular switch button should face toward you.
- **Corridors & Narrow Spaces:** Hold the scanner sideways so one lens points in your direction of travel. Use this orientation when scanning hallways, tight spaces, or moving through doorways.



Normal scanning



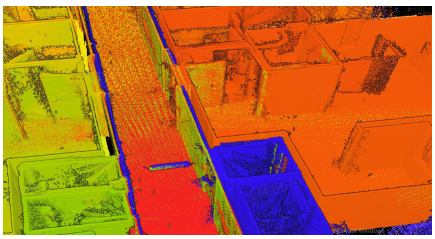
Switch button facing the operator



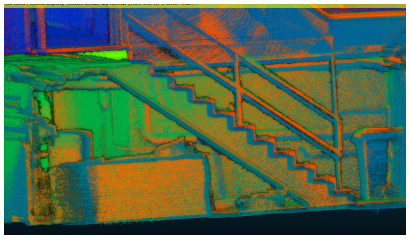
Scan sideways in narrow spaces like or when gettimg in/out of the room

4. **Large-Scale Scanning:**

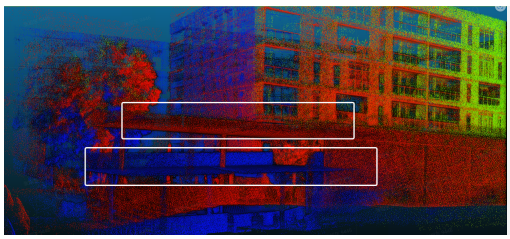
- **Trajectory Overlap:** Ensure scanning paths overlap at least once every 500 meters to prevent drift in results.
- **When Overlap Isn't Possible:** Use RTK (Real-Time Kinematic positioning) or place relative control points at trajectory gaps exceeding 500 meters.



Misalignment - indoor cubicles



Drift - multi-level location



Drift - large loops

Lixel L2 Pro Scanning

Lens Orientation:

- **Open Areas:** Hold the scanner with one lens facing left and one facing right relative to your walking direction. The circular switch button should face toward you.
- **Corridors & Narrow Spaces:** Hold the scanner sideways so one lens points in your direction of travel. Use this orientation when scanning hallways, tight spaces, or moving through doorways.



Normal scanning



Switch button facing the operator



Scan sideways in narrow spaces like or when gettimg in/out of the room

Illumination

General Lighting:

- Strive for a well-lit scanning area with uniform lighting.
- Avoid direct sunlight.

Indoor Scanning:

- Turn on lights and open curtains when scanning indoors.

Outdoor Scanning:

- The best time for outdoor scanning is around noon on cloudy days.

Poor Lighting Conditions:

- If good lighting cannot be guaranteed, reduce the scanning speed and increase scanning coverage (more perspectives).

Recommendations for light consistency for HD Enhancement/Map Fusion/Aerial-Ground Map Fusion:

- Complete all data acquisition within **2 hours** to maintain consistent lighting
- Avoid scanning across major lighting changes (morning/evening, sunny/cloudy transitions)
- When extended timing is unavoidable, prioritize well-lit areas with clear textures for overlap zones

Path Planning

Plan for loops in your scanning path to improve data quality.

Effective Loops:

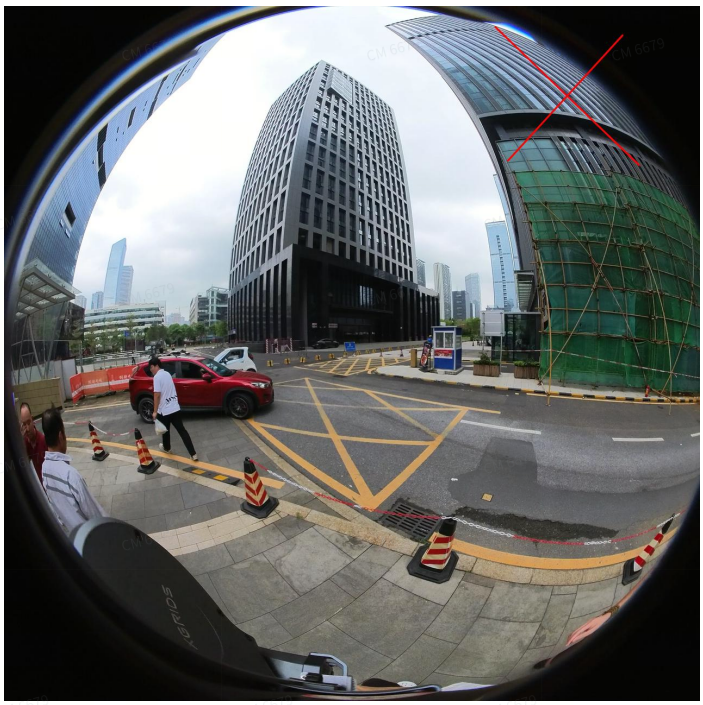
- An effective loop involves returning to a previously scanned location with a similar lens orientation (line of sight difference within +/- 40 degrees).





Recommended loop closure example





Incorrect: Angle difference between start and end points too big





Incorrect: Distance between start and end points too far

End Loops:

- When possible, create an end loop where the scan starts and finishes at the same point.

Midway Loops:

- It is recommended to include at least one loop midway through scanning in the following situations:
  - When meeting the effective loop criteria is difficult.
  - When scanning **large-scale** scenes.
  - When scanning spaces with significant **obstructions and narrow structures**.



When collecting in a narrow area
There are at least four smaller loops along the scanning route

Scanning Route

Coverage:

- Ensure the target scanning area is captured from multiple perspectives.

Route Type:

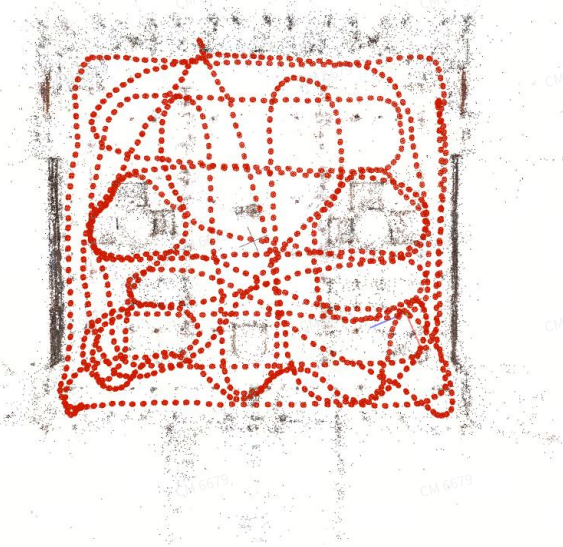
- Use serpentine (S-shaped) routes instead of straight routes, except in extremely narrow corridors.



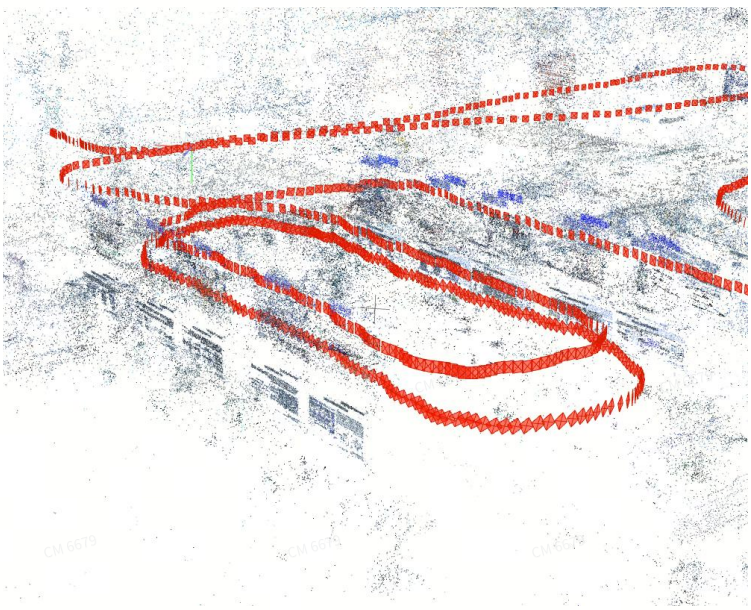
S-shaped route

Complex Scenes:

- For scenes with substantial occlusion or when scanning quality is paramount, consider reciprocating or saturated scanning:
  - Scan the scene using different routes.
  - Vary the scanner height, but avoid large changes at once (line of sight difference within +/- 40 degrees).
- Unlike LiDAR, standing still does not improve reconstruction quality.



Saturated scanning



Scanning at different heights

Dynamic Elements:

- Avoid scanning too close to:
  - Dynamic/digital screens
  - Windy foliage
  - Traffic
  - Pedestrian flow
- These elements can cause significant changes in the captured data.



Dynamic Display

Object Focus

Detailed Capture:

- Ensure that the object of interest has sufficient detailed image data, while also capturing the overall scene.

Examples:

- **Pipelines:** If pipelines are the main focus, capture as many pipelines as possible with the camera. For ceiling pipelines, use a pitch angle to obtain additional scans.

- **Text Details:** To capture text details, orient the camera towards the text and move slowly in an S-shaped pattern.
- **Statues:** For objects like sculptures or statues, scan around the object.

Uncertain Focus:

- When unsure of the focus or aiming for maximum quality, saturated scanning is often the most effective technique.



Pitch engle
for ceiling objects of interest



Scan slowly, S route
for text details



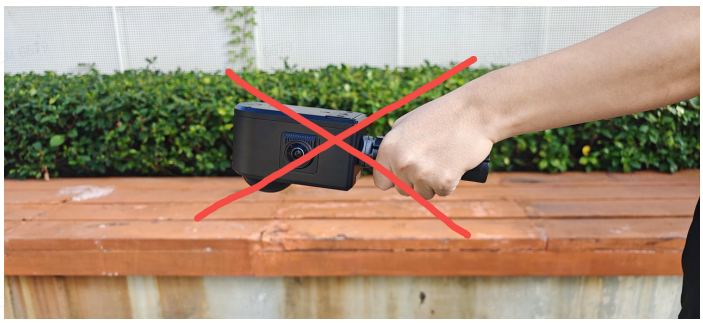
Surrounded scanning
for specific object

2. **Pitch Angle Limits**

- Keep device between -60° and +60° tilt
- Never point straight up or down



Avoid: Pitch greater than 60°



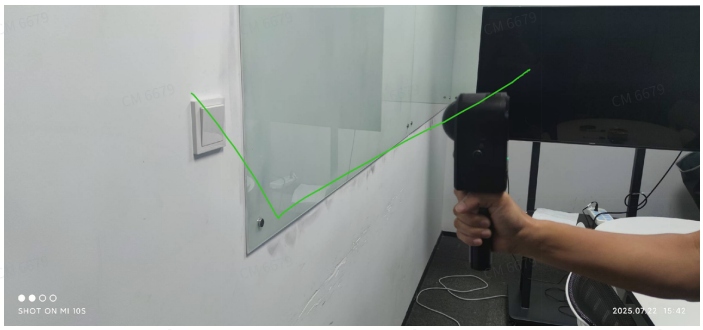
Avoid: pitch less than -60°

3. **Distance Requirements**

- **Subject distance**: Minimum 0.5m (forearm length) for high-resolution scanning
- **Wall clearance**: Minimum 0.5m from walls, avoid scanning in extremely narrow spaces



Avoid: Deivce is less than 0.5m from object



Correct: Device more than 0.5m from object

4. **Maximum Coverage Strategy**

When there are no particular focus objects, comprehensive saturation scanning (multiple angles and heights) provides the most effective results.

Speed of Movement

Minimize **motion blur, drastic lighting changes, and rapid occlusion changes**.

General Speed:

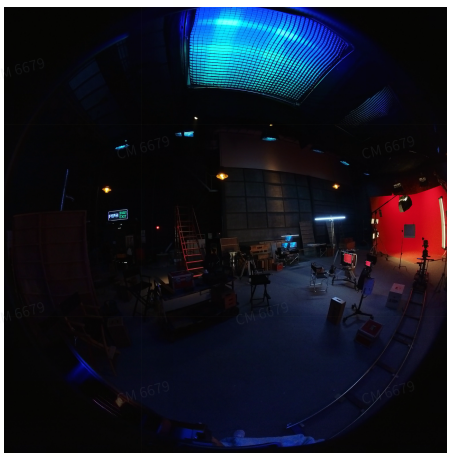
- Standing still does not improve results.
- The recommended walking speed is generally no more than 1 m/s.

Reduced Speed (⩽ 0.5 m/s):

- Reduce speed to 0.5 m/s (walking pace) in these scenarios:
  - Most indoor environments, hallways, or when targets are close to the camera.
  - Dark areas with poor lighting.
  - Entering or exiting doorways.
  - Turning corners or performing other rotations.



Scan at a close range



Low-light scene



Pass through the door

Initialization

Non-RTK Scanning

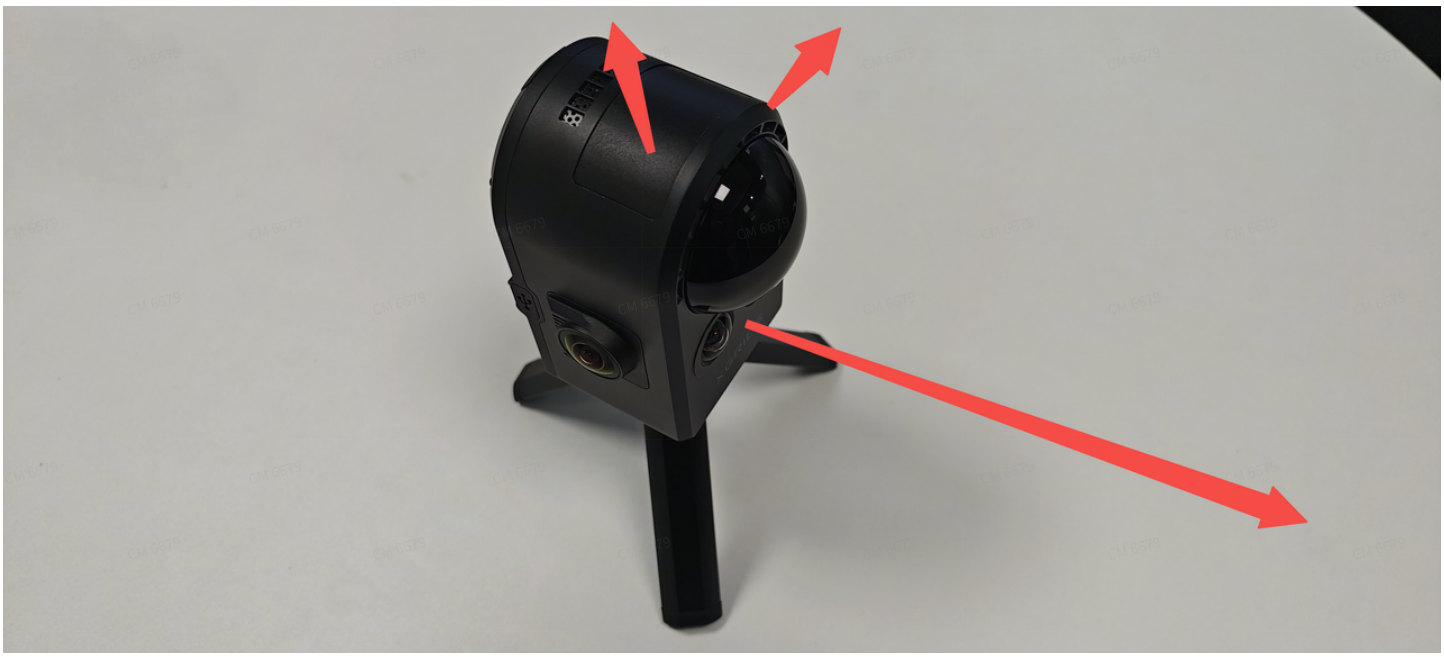
The reconstruction's initial viewpoint is set at the initialization location, so:

a. **Initialize in main display area** with device on the ground

b. **Capture detailed data around initialization point** to ensure clear, blur-free main scene from all angles

c. **For PortalCam**: Ensure front view faces clean areas—avoid crowds, vehicles, or high-movement/dynamic zones

RTK Scanning Initial viewpoint is set at the first valid RTK position.



PortalCam initialization position

Control Points

Control Points are a core feature introduced for PortalCam to support map fusion workflows (Map Fusion, Aerial-Ground Fusion, HD Enhancement). Ensure LCC Scan App ⩾ 1.2.0_p1 and firmware ⩾ V3.2.3-20251104.144651.

Control points enhance spatial consistency between multiple maps, improving fusion stability and accuracy.

The workflow follows the standard capture process with key differences in **Device Placement** and **Adding Control Points**.

1. Device Placement

When adding a control point:

a. Deploy the PortalCam tripod and place the device stably at the control point location

b. Choose locations with good lighting, clear textures, and unobstructed open areas

c. For shared control points across maps (for fusion), positions only need to be approximately consistent: distance difference <0.5m, orientation ±20°, height difference ~10cm

d. Control point placement by fusion type:

i. **Map Fusion**: ⩾3 control points in L-shaped distribution, spaced ⩾10m apart. Same control points must have identical names across maps.

ii. **Aerial-Ground Map Fusion**: Place control points at drone takeoff locations. PortalCam orientation must match drone camera direction. Store drone takeoff data in the same directory.

代码块

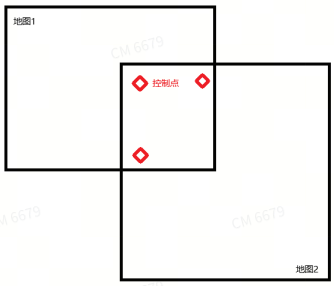
```
default_2025-11-02-142755      # Portalcam project file
├─ external_data
├─ project_data
│   ├─ log                      # log
│   │   ├─ data.ulg
│   │   ├─ lixel.zip
│   │   └─ project.json
│   ├─ model                    # potree model file
│   ├─ photo                    # camera photos for each control point
│   ├─ control_points.csv       # 控制点信息
│   ├─ gnss.csv
│   ├─ poses.csv
│   └─ preview_photo.jpg
└─ 2025-11-02-142755.xbin

Drone/                        # drone photo file
├─ DJI_202503191521_001/      # aerial photo folder 1
│   ├─ image1/                # aerial photo 1
│   ├─ image2/                # aerial photo 2
│   └─ ...
├─ DJI_202503191521_002/      # aerial photo folder 2
│   ├─ image1/                # aerial photo 1
│   ├─ image2/                # aerial photo 2
│   └─ ...                    # Icon, Language Pack, Multilingual Resources
├─ DJI_Link_1/                # Vertical Take-Off and Landing Photos Folder 1
│   ├─ image1/                # Take-off and Landing Photo 1
│   ├─ image2/                # Take-off and Landing Photo 2
│   └─ ...
|─ DJI_Link_2/                # Vertical Take-Off and Landing Photos Folder 1
│   ├─ image1/                # Take-off and Landing Photo 1
```

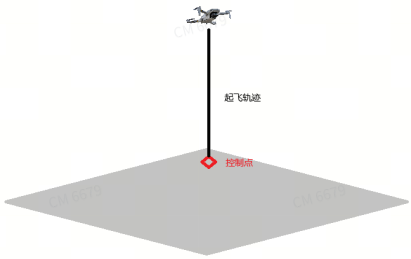
```
31  │   ├── image2/              # Take-off and Landing Photo 2
32  │   └── ...
33  └── ...
```

iii. **HD Enhancement**: Place control points in the enhancement area facing the target direction. Start HD capture directly above the control point. Store enhancement data in the same directory.

e. After placing the device, **walk one full circle around the control point area** to ensure 360° coverage—this significantly improves fusion algorithm stability.



Map Fusion



Aerial-Ground Map Fusion



HD Enhancement

2. Adding Control Points

With the device stably placed, open the capture interface in the companion app and select "Add Control Point."

Control point attributes:

- **Control Point ID**: Auto-generated unique number (cannot be duplicated)
- **Control Point Type**: Map Fusion / Aerial-Ground Map Fusion / HD Enhancement
- **Control Point Name**: User-defined name to identify same-named points across maps

Select the appropriate type based on your scenario. After creation, the system records position and orientation data for reconstruction and fusion.

Important: Do not power off within 5 seconds of adding a control point to prevent file loss.

Ensure the control point's field of view is unobstructed and avoid direct harsh lighting to minimize positioning errors.



Place Device



LCC Scan: Add New Control Point

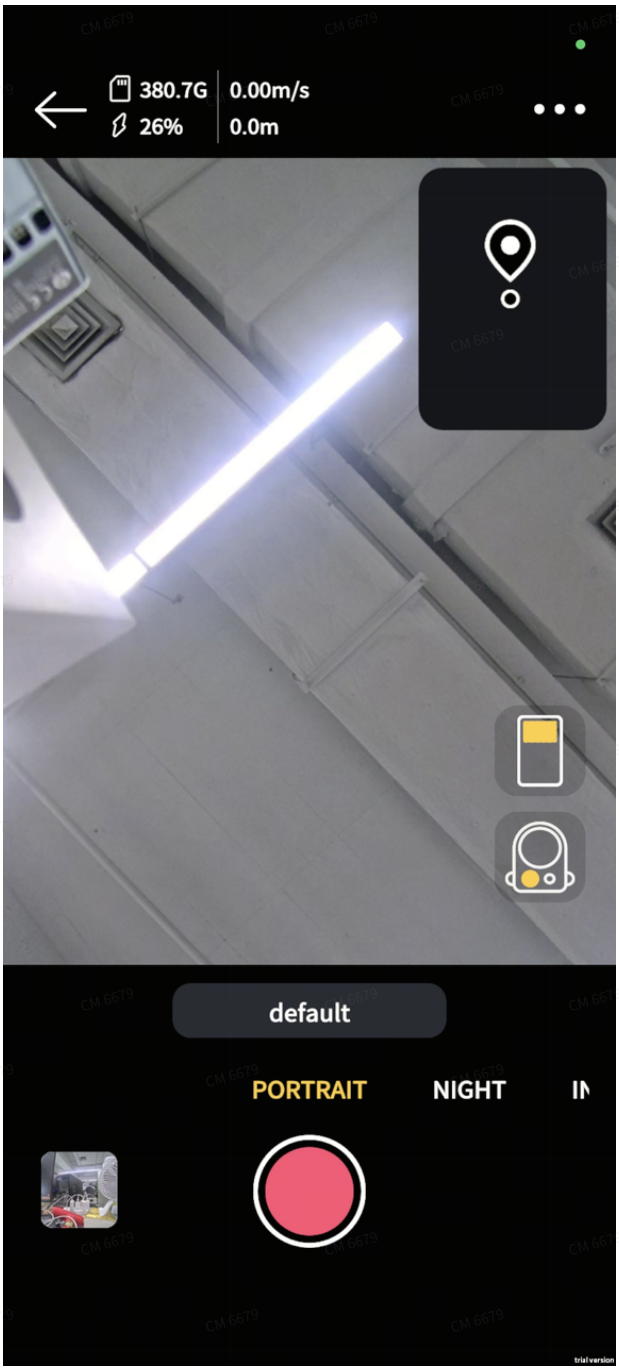
Portrait Mode

Portrait Mode is PortalCam's specialized scanning mode for human subjects. Follow the same overall capture process as described above, and pay special attention to initialization and capture techniques for optimal results.

1. Initialization

Before Scanning:

- Select **PORTRAIT** mode in capture interface.
- **Avoid** pointing front camera at your subject(s) during initialization to give them some time to prepare.
- Maintain stable device position with uniform lighting (no harsh direct light or bright backgrounds).
- Wait for **"Ready for Capture"** prompt before proceeding.



2. Capture Technique

Movement Pattern:

- Circle the subject while keeping the front camera module aimed at them from all angles

Subject Requirements:

- **Must remain as stationary as possible**—changes in posture or facial expressions can cause reconstruction errors
- **Multiple subjects:** Independent movement between subjects increases reconstruction complexity. Achievable with careful coordination, but expect higher sensitivity to motion.

Capture Sequence (Top-Down):

1. Head and face first

2. Transition to body and lower extremities
3. Minimize facial area duration to prevent motion blur
4. **Target: ~2 minutes total** (balances data quality with subject comfort)

Quality Check:

- Use LCC Scan for real-time verification of critical region coverage

Advanced Features

Map Fusion

Software:

- LCC Studio 1.6.0 and later versions support map fusion.

Data Limits:

- The map fusion function supports up to 10 separate scans with a total scanning time of no more than 200 minutes.

Device Compatibility:

- All data being fused must come from the **same scanning device model**.

Overlap Requirements:

- Separate, consecutive scans require approximately 15 meters of overlapping area.
- Avoid:
  - Overlap areas that are too small (less than 10 meters).
  - Situations where one scan area almost completely overlaps another.

Overlap Placement:

- Select overlapping areas with rich texture whenever possible.
- Avoid overlap areas in:
  - Low light
  - Stairs
  - Narrow corridors
  - Reflections

Stitching Methods:

- Scans can be fused using RTK or relative control points.
- Each scan must be associable with other scans through either method.

- If any scan has valid RTK, the fusion result will have global coordinates.

Fusion Examples:

- **Example 1:** 3 separate scans; scans 1, 2, and 3 all have RTK.
- **Example 2:** 3 separate scans; scans 1 and 2 share control points with the same names, and scans 2 and 3 share control points with the same names.
- **Example 3:** 3 separate scans; scan 1 has RTK, scans 1 and 2 share control points with the same names, and scans 2 and 3 share control points with the same names.
- **Example 4:** 3 separate scans; scans 1 and 2 have RTK, and scans 2 and 3 share control points with the same names.

Aerial-Ground Map Fusion

Combines drone aerial images with ground-level Lixel data for complete multi-angle reconstruction. Best suited for large sites, building complexes, nature parks, and complex terrain needing comprehensive modeling.

Requirements:

- Both **drone and handheld scanner** must have **RTK enabled**.
- Coordinate system must be set to **WGS84**.
- RTK signal must be strong during scanning.
- Drones with multifocal cameras must use the **same focal length** for all images in a processing project.
- Aerial-ground map data must include both **aerial** and **takeoff/landing sections**.
- In LCC Studio v1.8.0, the ground does **not** support map fusion; the air requires 100–2000 aerial drone images.
- Recommended Drones:

Recommended	Acceptable	Not Recommended
Zenmuse P1	DJI M3E DJI M4E DJI P4R	DJI M3T FC3582

Aerial Data Capture

Capture the aerial data according to standard **oblique photography** practices.

Flight Pattern: For best results, use a tic-tac-toe flight pattern.

Overlap: Maintain a scanning path overlap rate ⩾ 85%.

Altitude: Fly at the lowest safe altitude (generally no higher than 50 meters, unless restricted).

Multiple Passes:

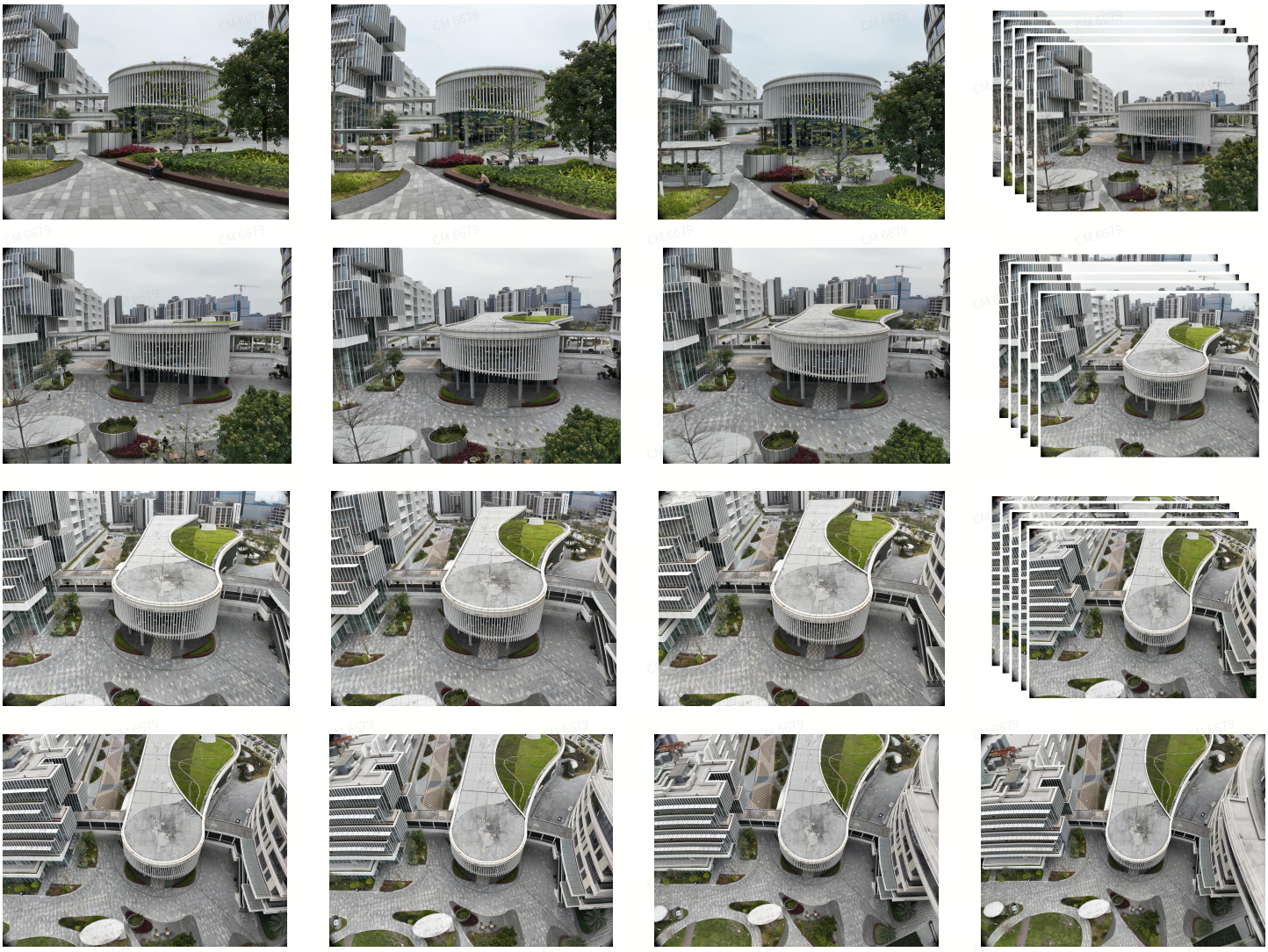
- For simple, small to medium-sized areas, one round at the lowest safe altitude may suffice.
- For large areas with complex structures, conduct 1-2 additional rounds above the lowest level for improved robustness.
- The height difference between adjacent rounds should not exceed twice the lower altitude.

Takeoff and Landing Capture

The takeoff and landing section is crucial for fusing aerial and ground perspectives.

Capture Guidelines:

- Plan at least **3-4 takeoff and landing shots per case**, distributed throughout the scanning path.
- For larger cases, aim for at least **1 takeoff/landing shot every 50-100 meters**.
- Each takeoff and landing sequence should provide **continuous images** from approximately 1.5 meters above the ground to a partial height in the air, meeting these requirements:
  - **Ground-Level Shots:**
    - Position and perspective should **sufficiently overlap** with the **handheld scanner's trajectory**.
    - Due to the drone's typically smaller field of view (FOV), the drone can be positioned slightly farther from the subject of interest at takeoff/landing to ensure better coverage (prioritizing viewing angle), but not exceeding 1.5 times the distance of the handheld scan.
  - **Overhead Shots:**
    - When transitioning from ground to air, position and capture angle must have sufficient overlap with the flight path imagery.
  - **Smooth Transition:**
    - The camera position and angle should transition smoothly from ground to aerial perspectives.
    - Adjacent image overlap rate ⩾ 85%.





Recommended take-off

Examples of errors :





Adjacent images rotate too much.



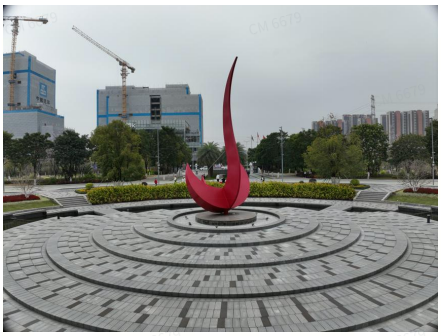


The position of adjacent images changes too much

Takeoff and Landing Position Requirements:

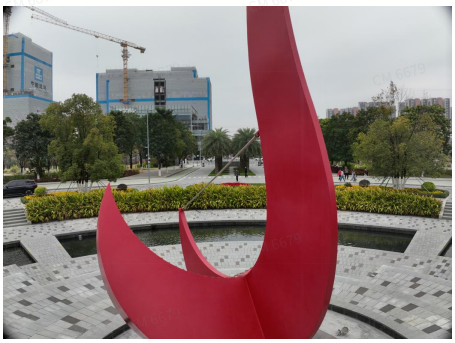
- The drone camera's view should be relatively unobstructed for at least 10 meters.
- **Subject Selection:**
  - Orient the drone towards subjects with distinctive features (buildings, facades, etc.).
  - The ground portion of multiple takeoff/landing sequences can face the same subject.
  - Avoid takeoff/landing near indistinct subjects (uniform colors, reflections, repetitive structures).

Correct examples :

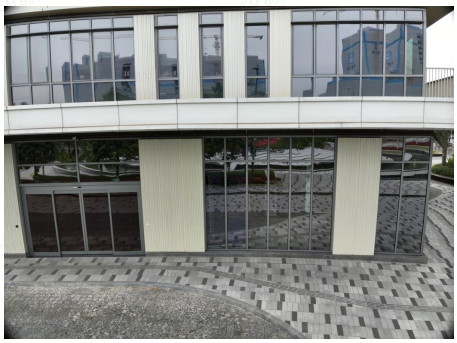




Examples of errors :



Too close to obstruction



Reflective surface



Indistinguishable subjects with uniform color

Aerial Reconstruction

Aerial reconstruction follows standard oblique photography requirements, identical to Aerial-Ground Map Fusion aerial components.

Performance Indicators Table

Drone Model	Survey Area (m^2)	Oblique GSD (cm)	Flight Altitude (m)	Smart Photography Duration	Drone Image Count
M4E	10,000	0.5	12	2h 8min	11139
		1	26	28min	2390
		2	53	9min	633
		3	79	6min	284
	50,000	0.5	12	9h 20min	53316
		1	26	1h 55min	11399
		2	53	32min	2847

		3	79	17min	1279
	100,000	0.5	12	18h 13min	105308
		1	26	3h 43min	22448
		2	53	1h 1min	5563
		3	79	29min	2475
M3E	10,000	0.5	12	2h 45min	11197
		1	26	36min	2430
		2	53	12min	633
		3	79	7min	335
	50,000	0.5	12	11h 32min	53406
		1	26	2h 22min	11534
		2	53	40min	2880
		3	79	21min	1267
	100,000	0.5	12	22h 14min	105593
		1	26	4h 33min	22693
		2	53	1h 15min	5620
		3	79	38min	2496

HD Enhancement

Purpose:

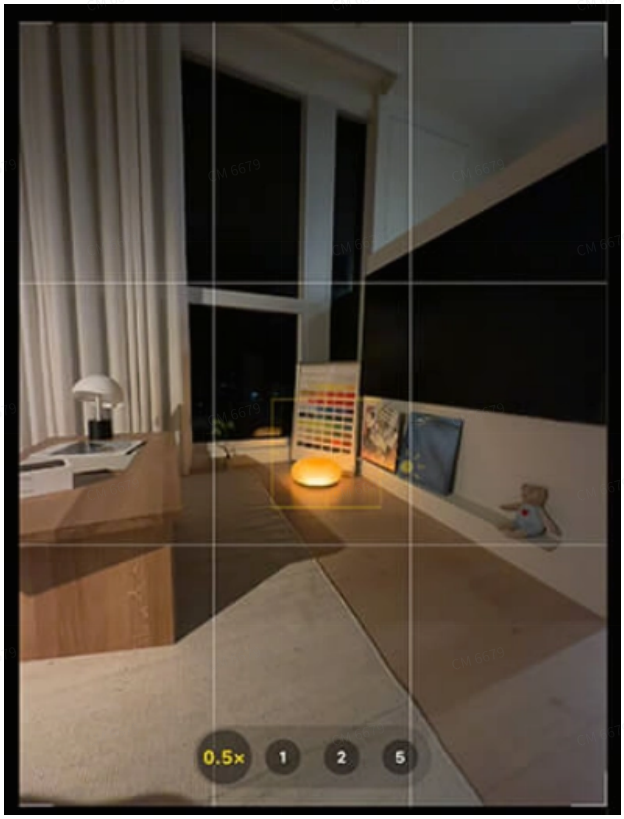
- HD Enhancement improves local reconstruction by integrating high-definition image sequences of small scenes.
- In LCC Studio, adding up to 20 - 500 images for L series, 20 - 1000 images for P series (JPG, PNG, JPEG) is supported.

Image Requirements:

- **Consistency:** Image sequences must have the same camera focal length and resolution.
- **Avoid:**

- Mixing lenses
- Changing zoom lens focal length
- Scaling/cropping images

- **Optimal FOV:** ~100 degrees horizontal (e.g., wide-angle on a smartphone, 16mm full-frame SLR).



Adjust smartphone to wide-angle lens mode (the model in the image is 0.5x).



Adjust DSLR lens to around 16mm focal length.

Image Quality: Ensure images are sharp. Avoid focus, motion blur, or exposure errors.。



Out of focus



Motion blur



A large portion of the image is not in focus/blurred



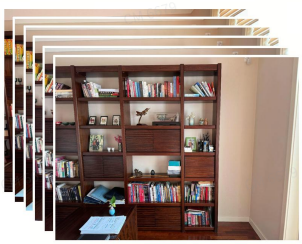
Under-exposed



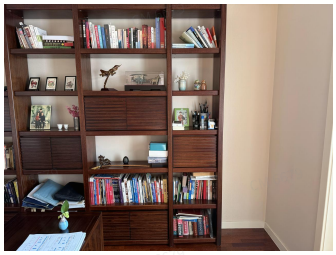
Over-exposed

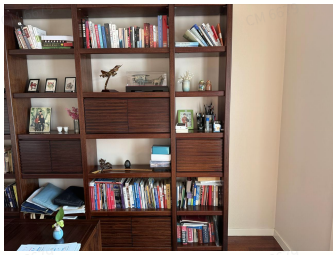
Capture Position:

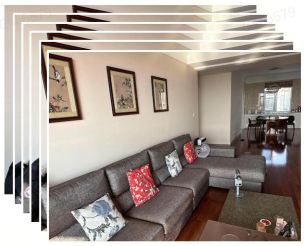
- Plan image positions/orientations carefully, avoiding problematic scenes for higher success.
- **Image Count/Overlap:**
  a. Capture ⩾20 continuous images per area with >80% overlap. Minimize camera movement/rotation.











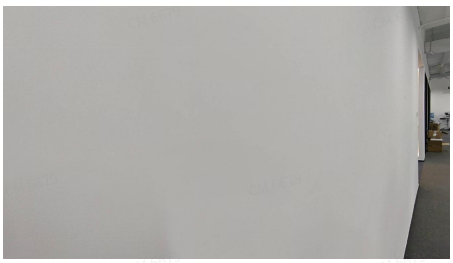



Include **at least 1 image per sequence** with a similar **lens position/orientation** to the Lixel device used. More overlap improves results.

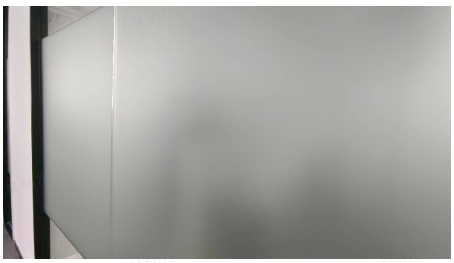



Avoid/Minimize proportion in image captures:

- Low-texture (solid color) areas
- Repetitive-texture areas
- Reflective areas (highlights, mirrors)
- Dynamic scenes (moving objects)



Low texture: white walls



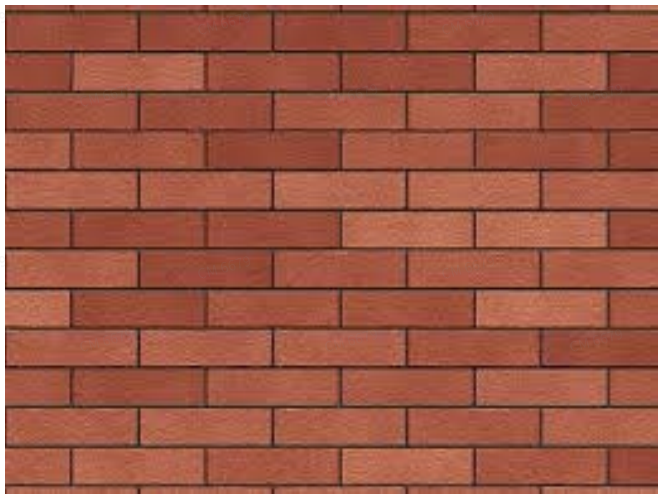
Low texture: frosted glass



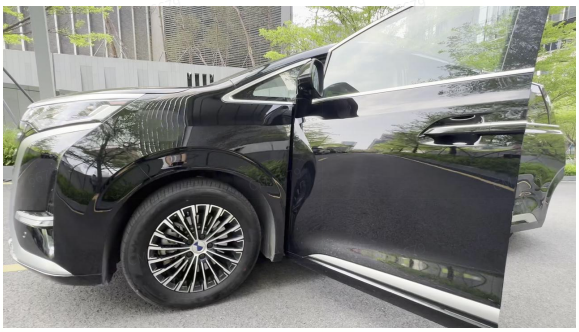
Low texture: frosted glass



Repetitive texture: lawn



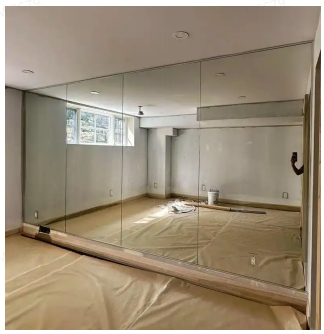
Repetitive texture: brick wall



Reflective surface: polished surface



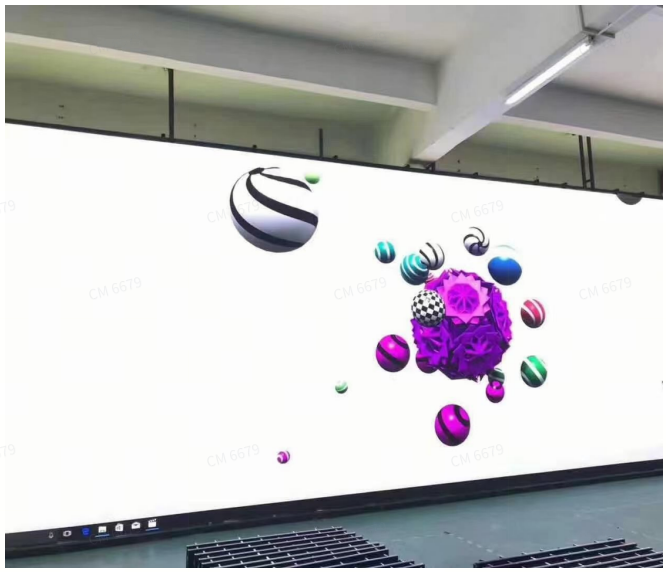
Reflective surface: water body



Reflective surface: mirror



Dynamic scene: tree brances



Dynamic scene: LED screen

- **Post-Capture:** Discard non-compliant photos to avoid negative impact on reconstruction.

Spatial Recognition

Floorplan

Purpose: Automatically identifies room layouts and building elements through scanning, creating AI-generated elements for use with the LCC for Revit plugin to build indoor BIM models.

Requirements:

1. **Best for**: Single-floor apartments, offices, and regular indoor spaces with rectangular layouts
2. **Single Operator Scanning**: Scan alone to avoid people in camera views and reduce shadows that interfere with AI processing
3. **Speed**: Keep under 0.5m/s indoors for higher point cloud density and more complete capture
4. **Entry doors:** Keep closed and scan thoroughly from 0.5-1m away to capture full details
5. **Interior doors:** Leave half-open, pause 5 seconds before and after passing through doorways
6. **Key Component Coverage**: Get good coverage of doors, windows, beams, columns, pipes, and balconies by angling the scanner toward them and moving in S-patterns