

#WWDC18

Understanding ARKit Tracking and Detection

Session 610

Marion Maerz, ARKit Engineer
Michele Stoppa, ARKit Engineer







Orientation Tracking



Orientation Tracking



World Tracking



Orientation Tracking



World Tracking



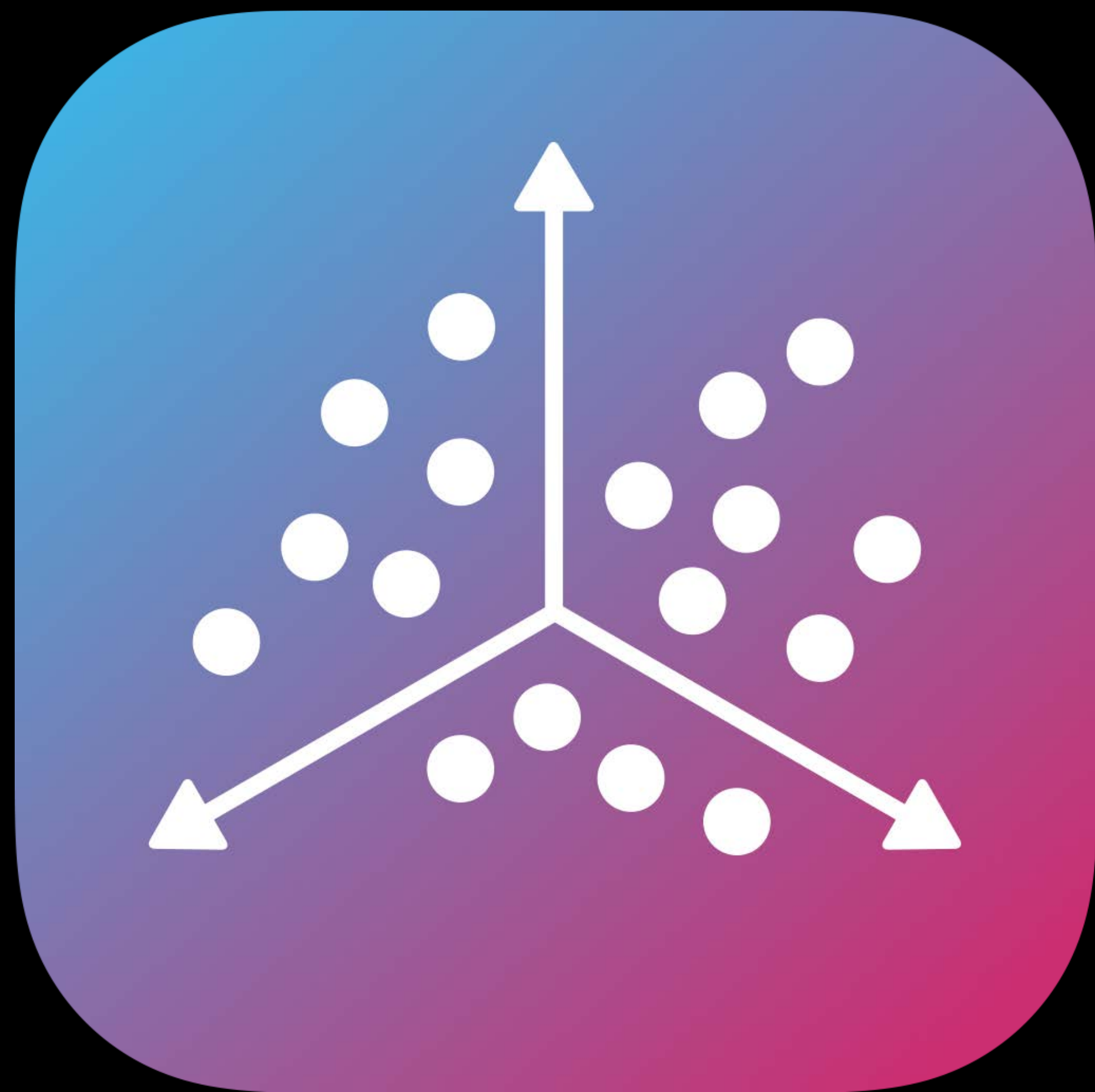
Plane Detection

NEW



Saving and
Loading Maps

NEW



Saving and Loading Maps



Image Tracking

NEW



Saving and Loading Maps



Image Tracking



Object Detection

Basics of ARKit

Recap

ARSession

Basics of ARKit

Recap

ARConfiguration

ARSession

Basics of ARKit

Recap

```
run(_ configuration)
```

ARConfiguration

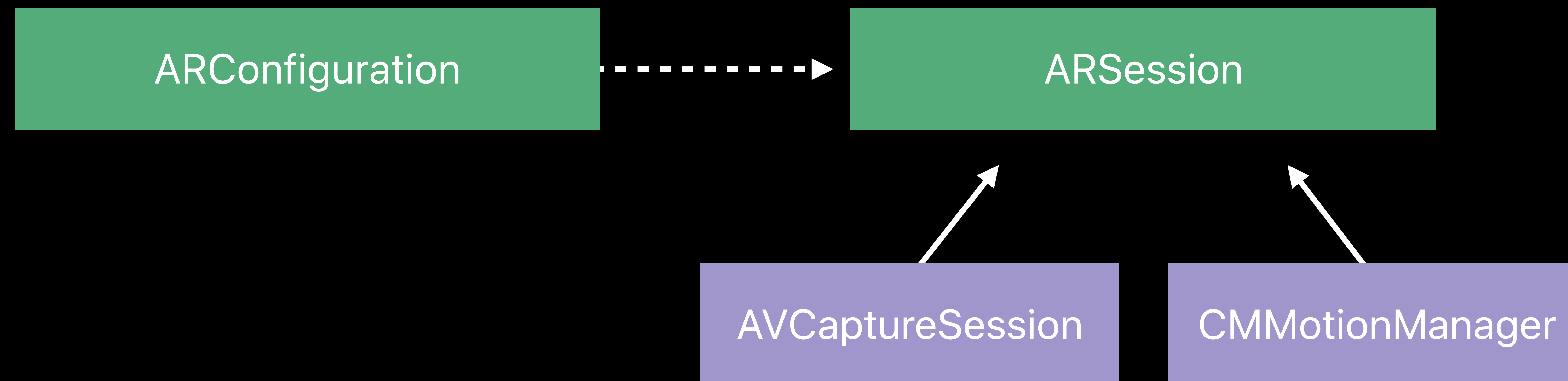


ARSession

Basics of ARKit

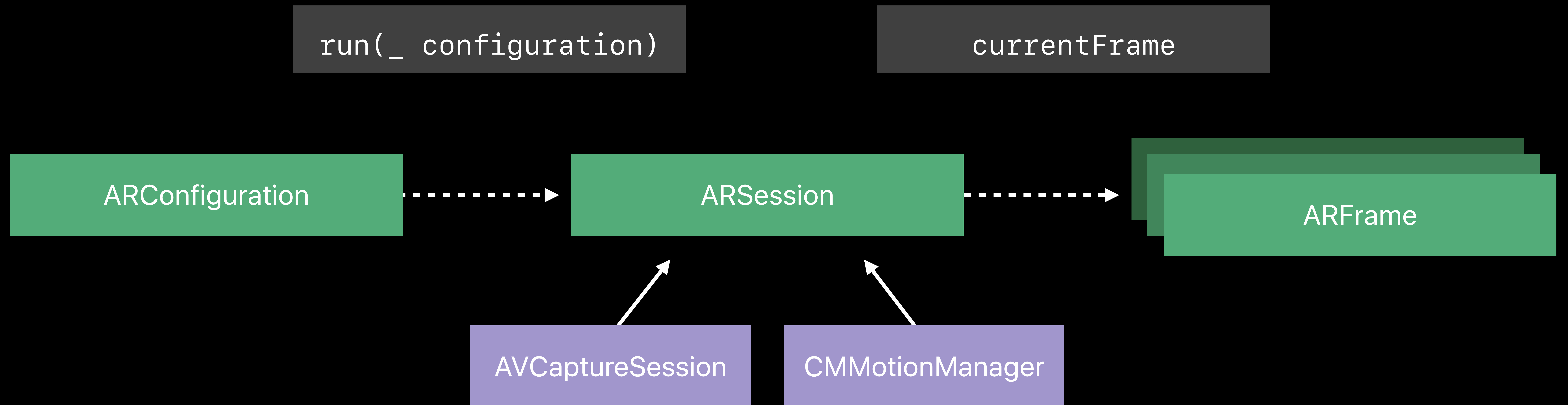
Recap

```
run(_ configuration)
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Basics of ARKit

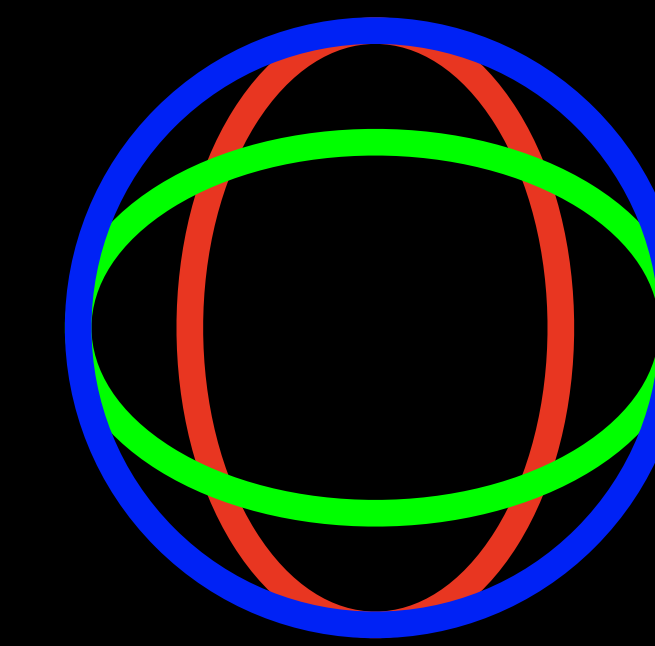
Recap



Orientation Tracking

Orientation Tracking

Tracks orientation only (3 DoF)



Orientation Tracking

Tracks orientation only (3 DoF)

Spherical virtual environment



Orientation Tracking

Tracks orientation only (3 DoF)

Spherical virtual environment

Augmentation of far objects



Orientation Tracking

Tracks orientation only (3 DoF)

Spherical virtual environment

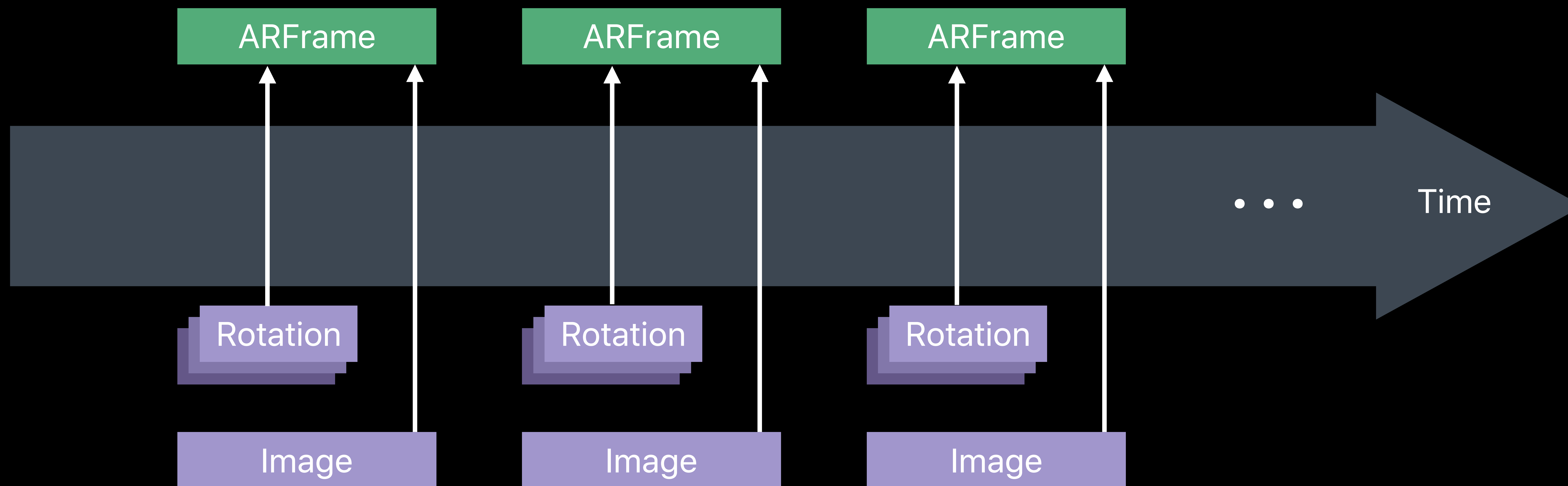
Augmentation of far objects

Not suited for physical world
augmentation from different views



Behind the Scenes

Rotation data



Orientation Tracking API

```
AROrientationTrackingConfiguration
```



Orientation Tracking API

```
AROrientationTrackingConfiguration
```

```
open class ARCamera : NSObject, NSCopying {  
    open var transform: simd_float4x4 { get }  
    open var eulerAngles: simd_float3 { get }  
    ...  
}
```



Orientation Tracking API

```
AROrientationTrackingConfiguration
```

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open class ARCamera : NSObject, NSCopying {
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    open var transform: simd_float4x4 { get }
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    ...
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Orientation Tracking API

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AROrientationTrackingConfiguration
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open class ARCamera : NSObject, NSCopying {
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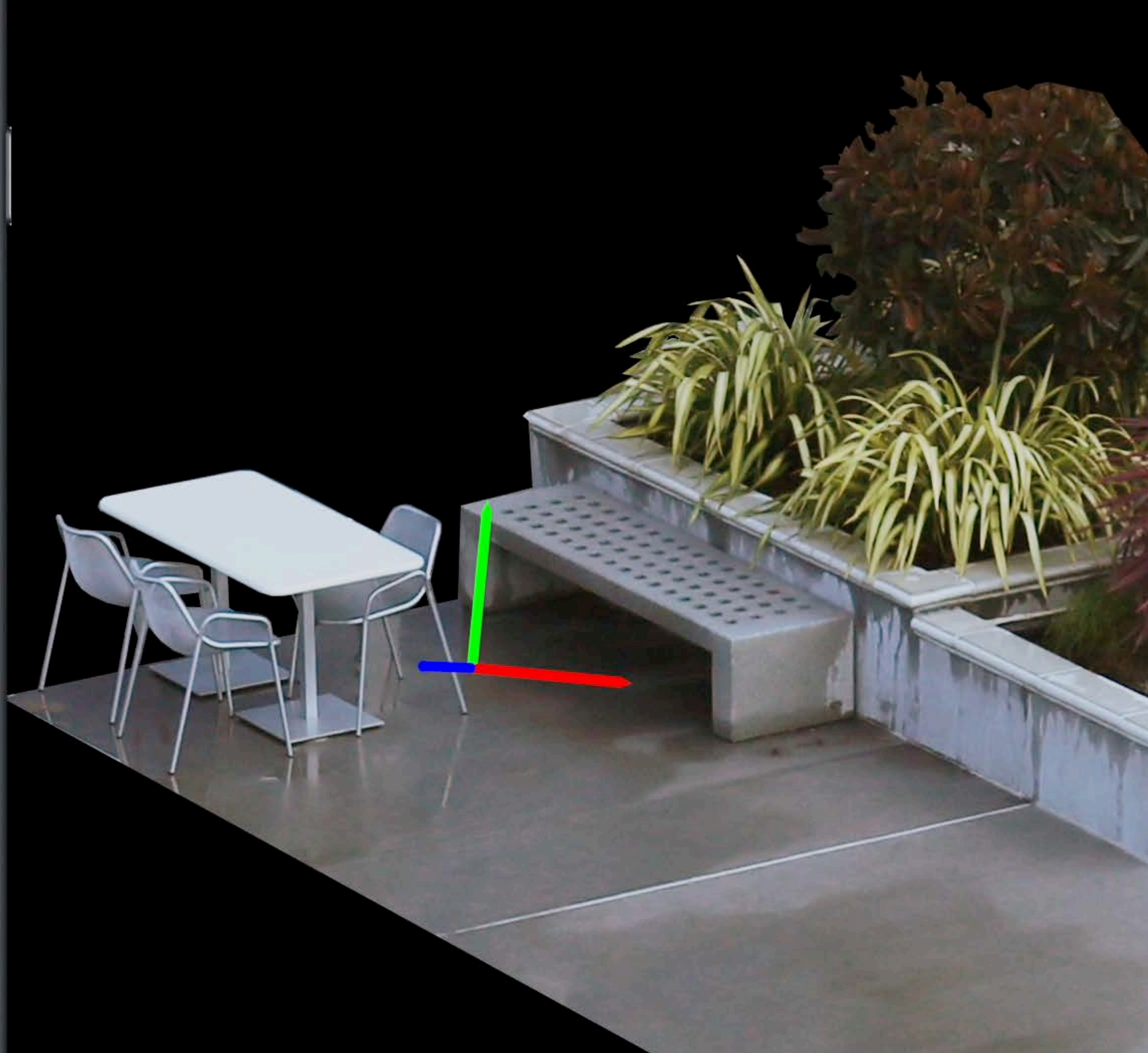
```
    open var eulerAngles: simd_float3 { get }
```

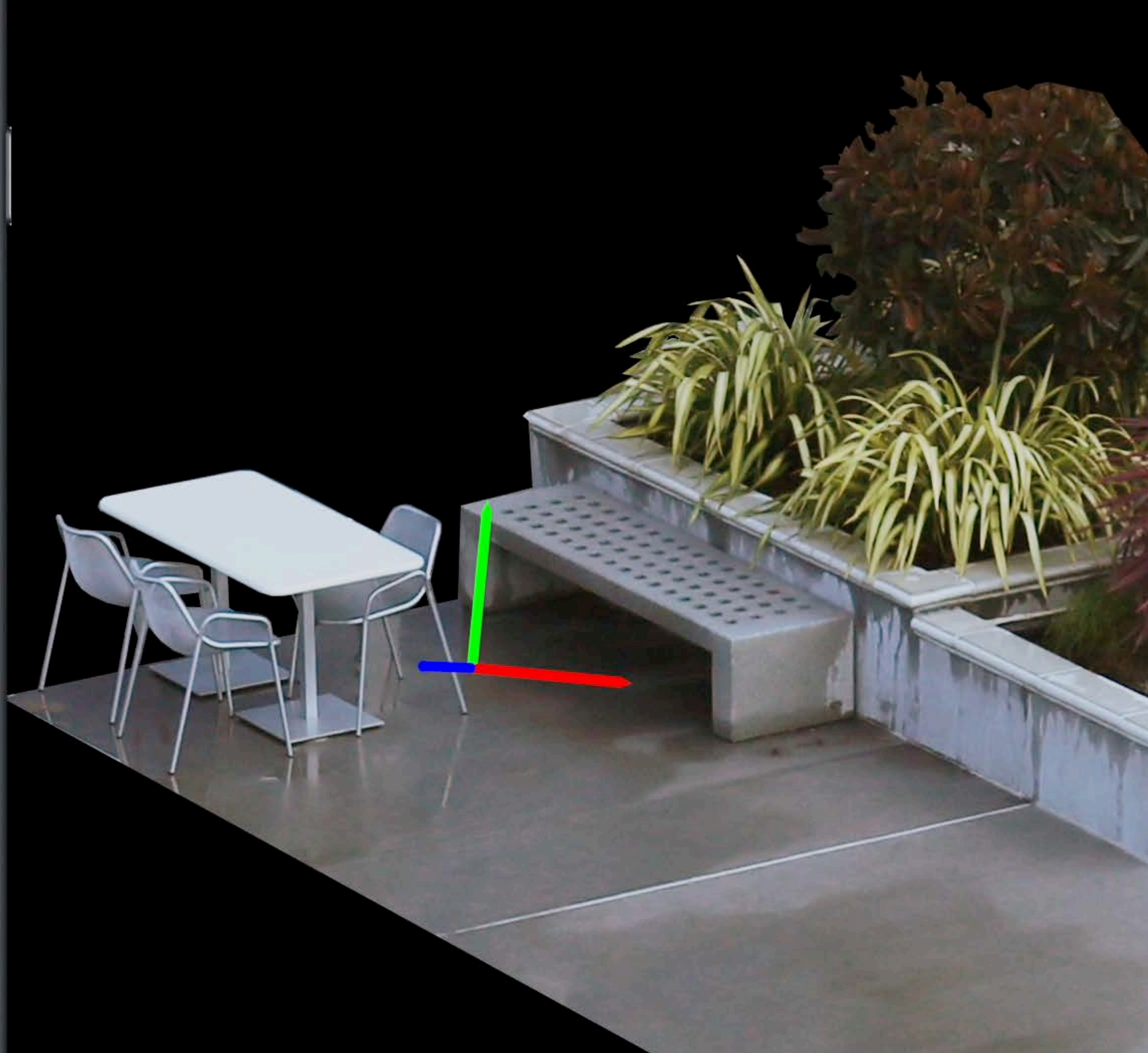
```
    ...
```

```
}
```



World Tracking





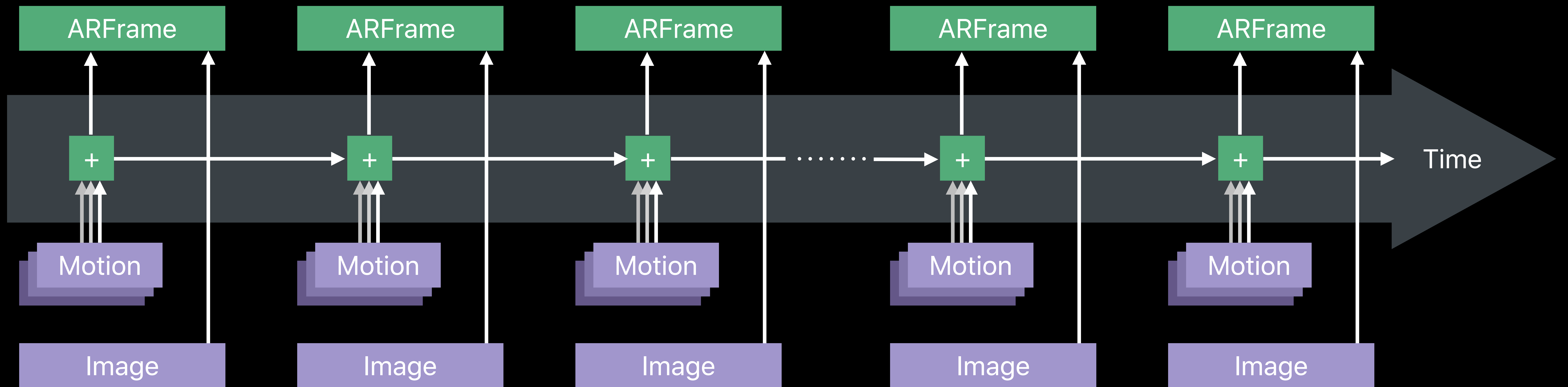
Behind the Scenes—Inertial Odometry

Motion sensor



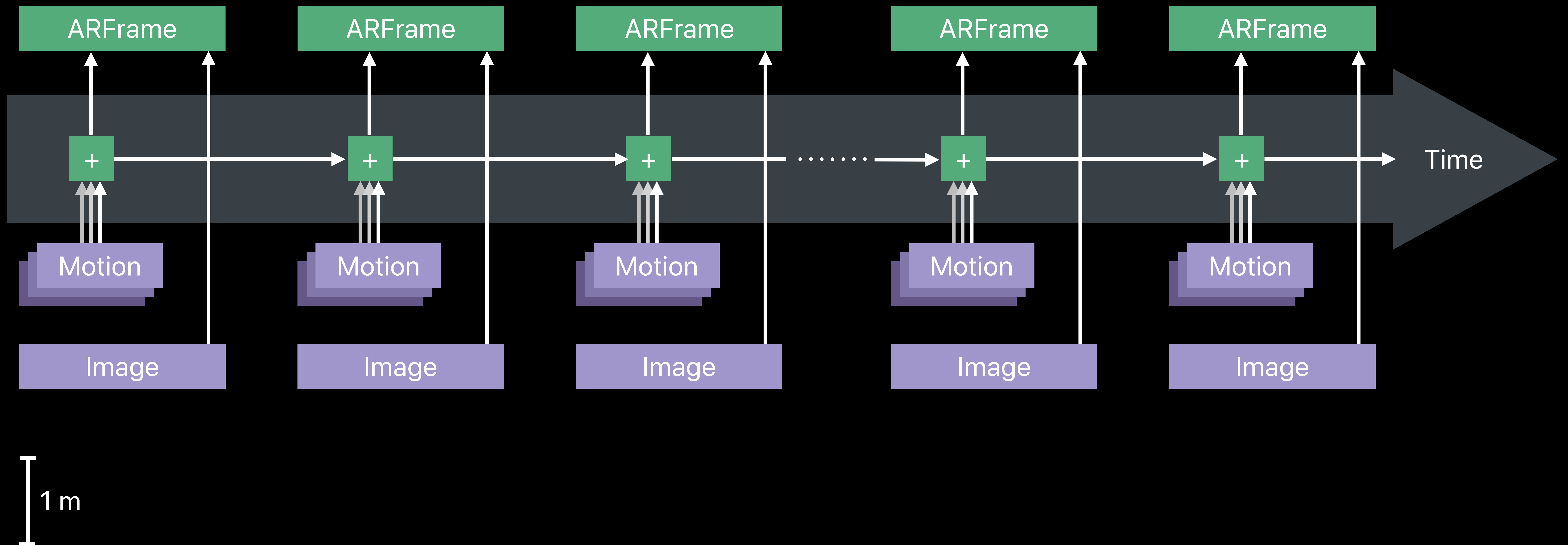
Behind the Scenes—Inertial Odometry

Motion sensor



Behind the Scenes—Inertial Odometry

Motion sensor



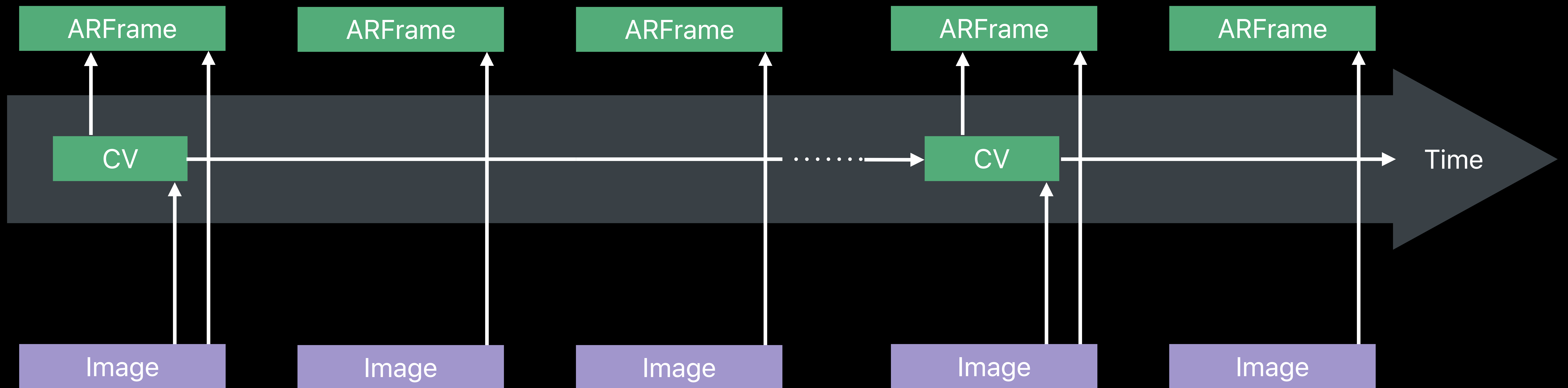
Behind the Scenes—Visual Odometry

Computer vision



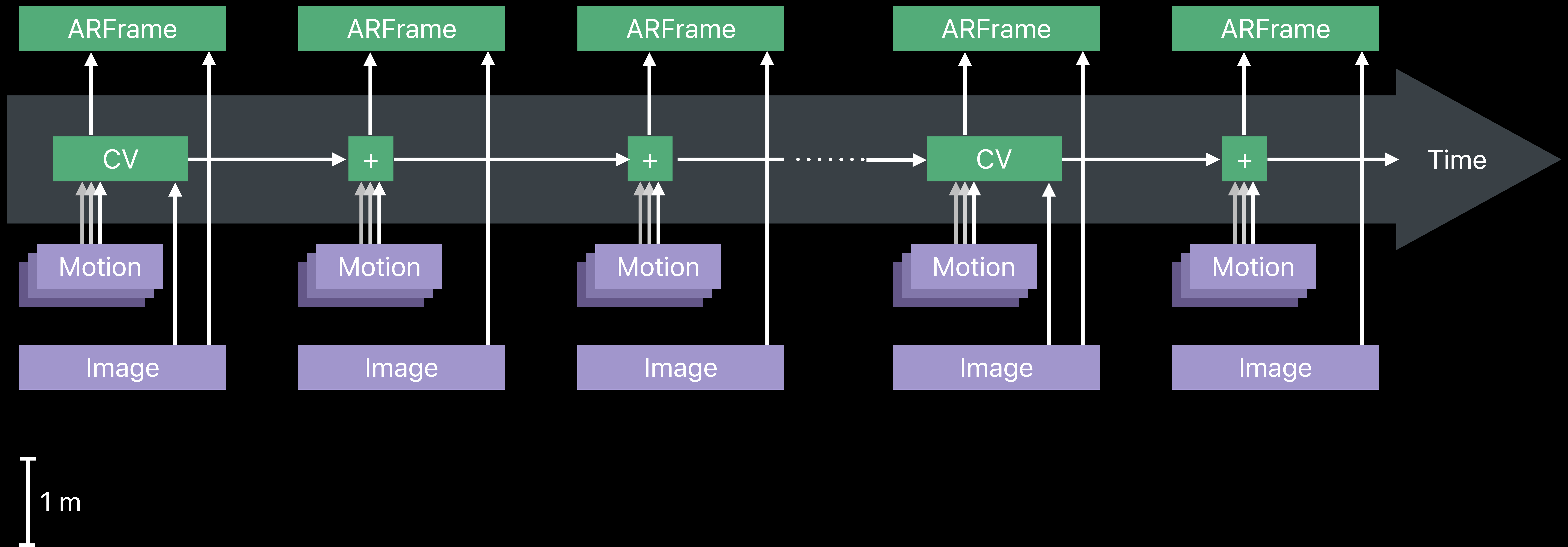
Behind the Scenes—Visual Odometry

Computer vision



Behind the Scenes—Visual Inertial Odometry

Motion data and computer vision



Behind the Scenes—Visual Inertial Odometry

Extracting robust features



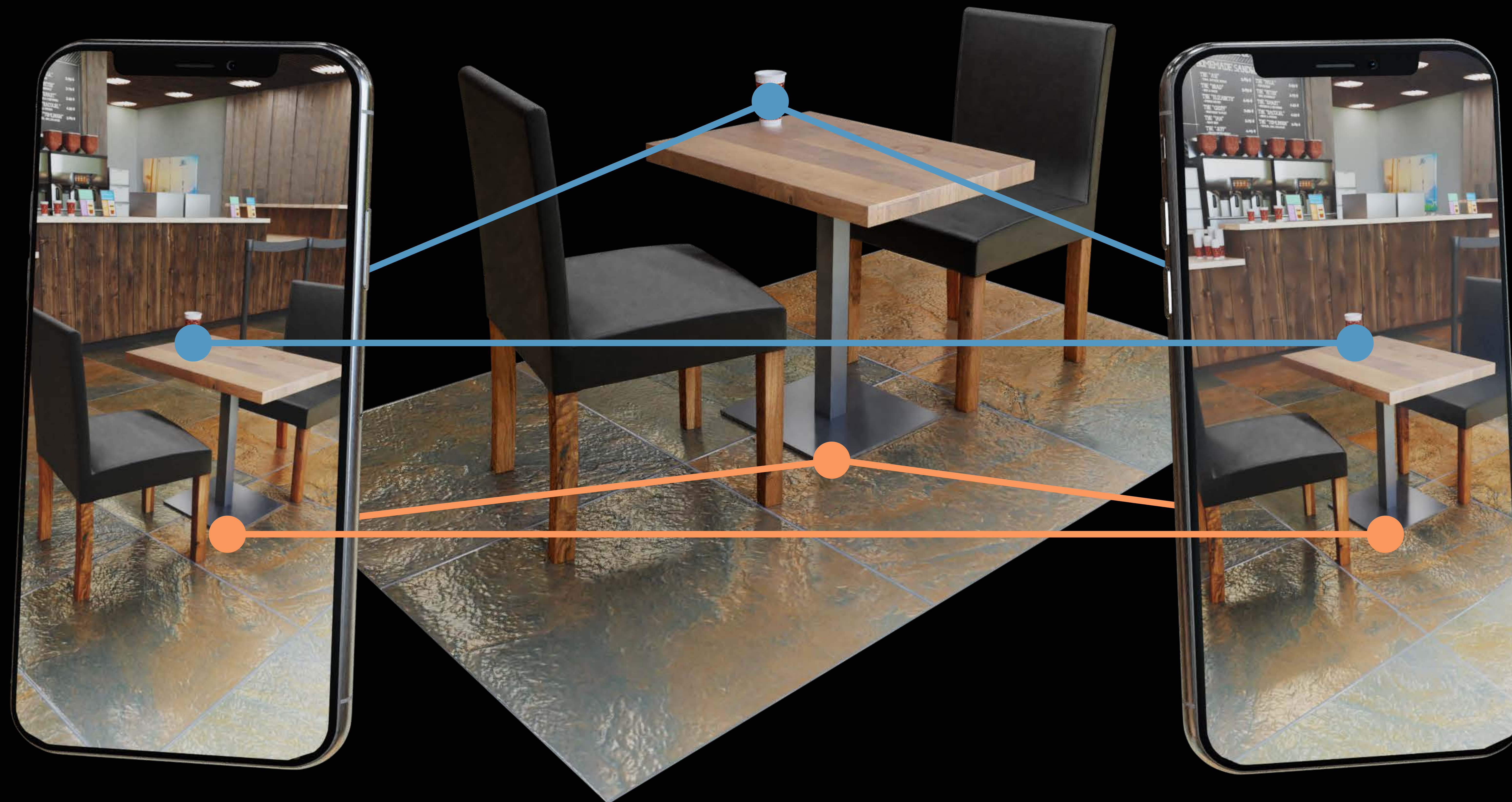
Behind the Scenes—Visual Inertial Odometry

Matching features



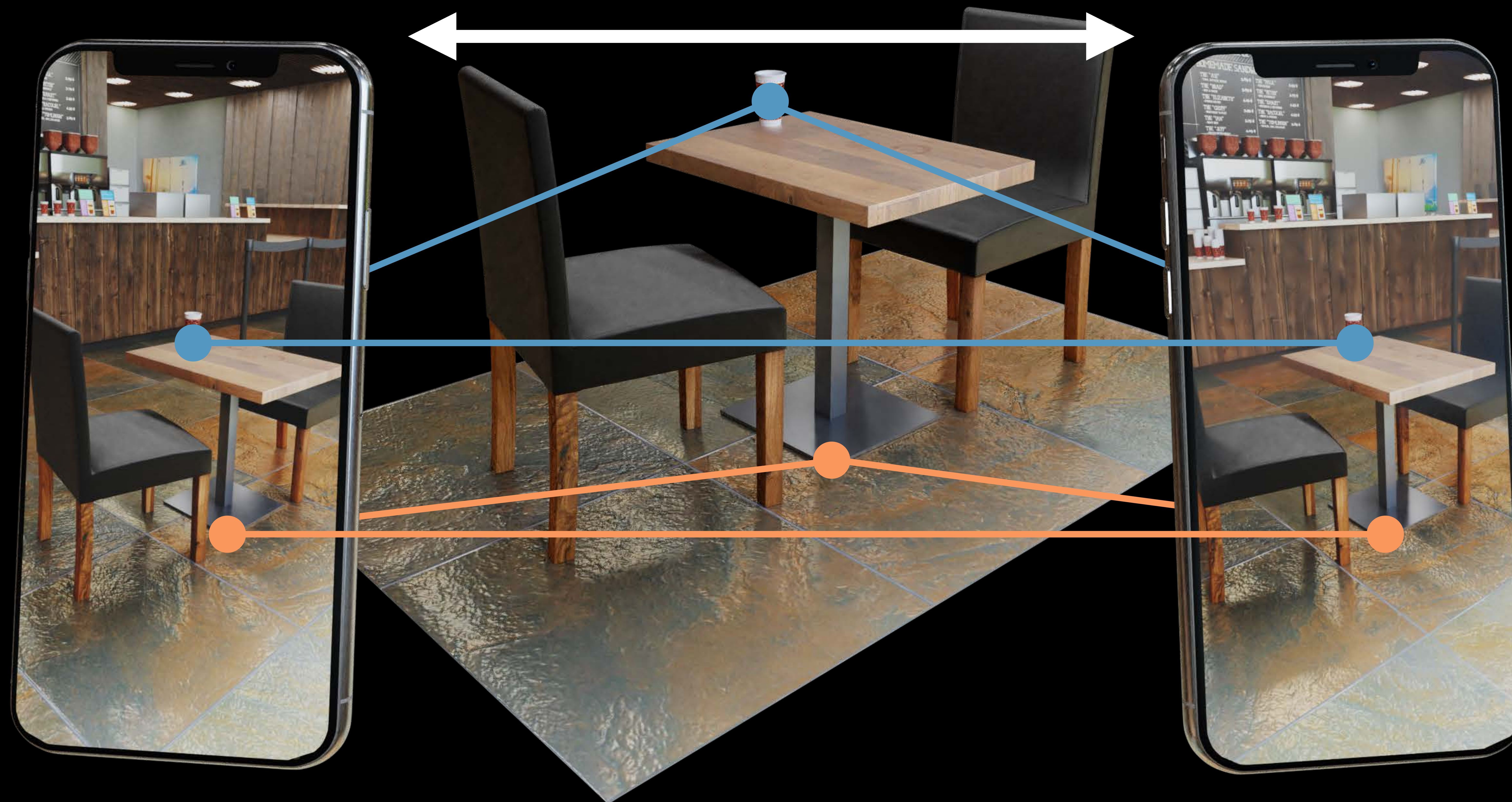
Behind the Scenes—Visual Inertial Odometry

Triangulation creates World Map



Behind the Scenes—Visual Inertial Odometry

Triangulation creates World Map



Behind the Scenes—Visual Inertial Odometry

Initialization



Behind the Scenes—Visual Inertial Odometry

Initialization



Behind the Scenes—Visual Inertial Odometry

Initialization



Behind the Scenes

Augmentation



Behind the Scenes

Augmentation



Behind the Scenes

Augmentation



Behind the Scenes

Augmentation



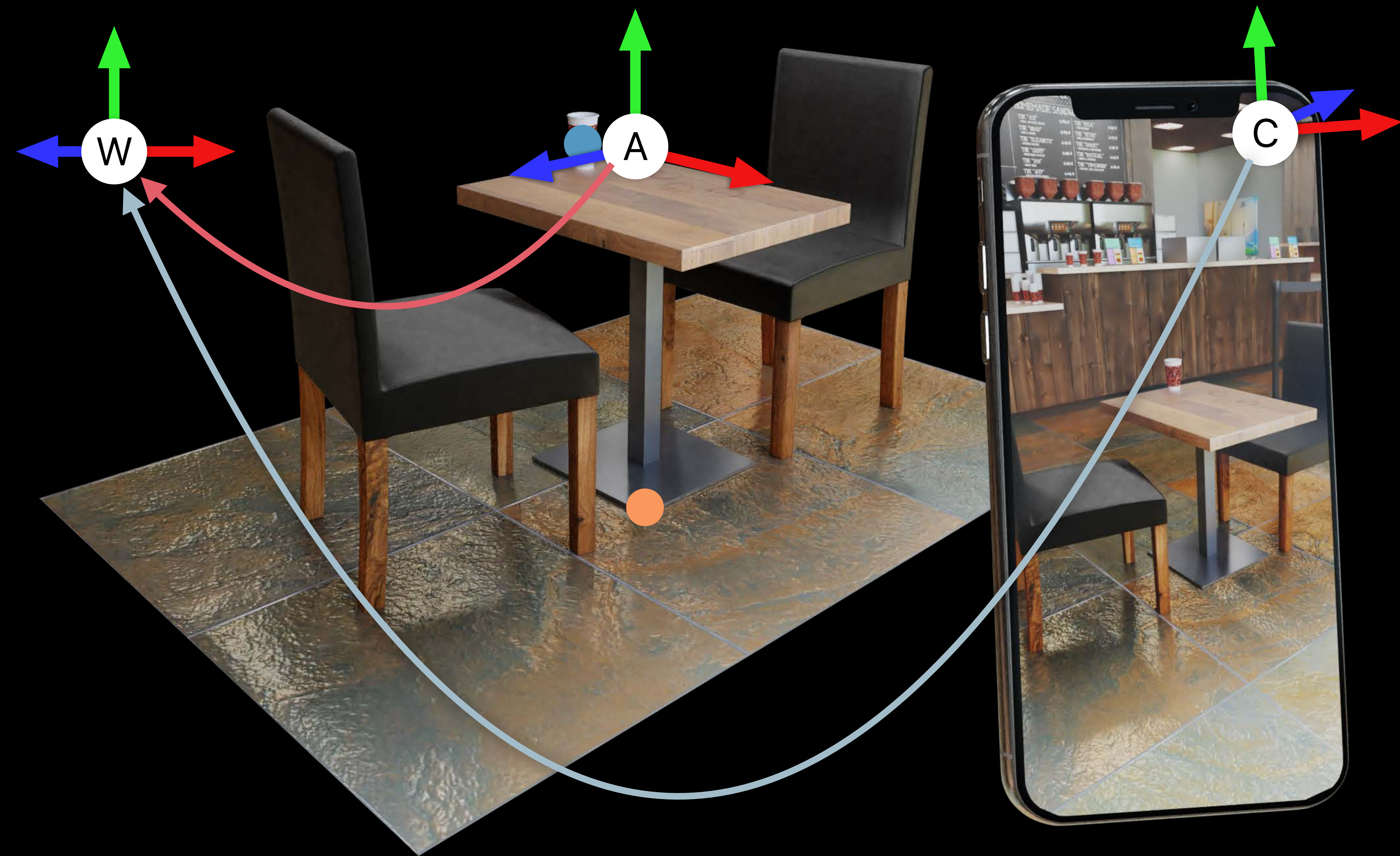
Behind the Scenes

Augmentation



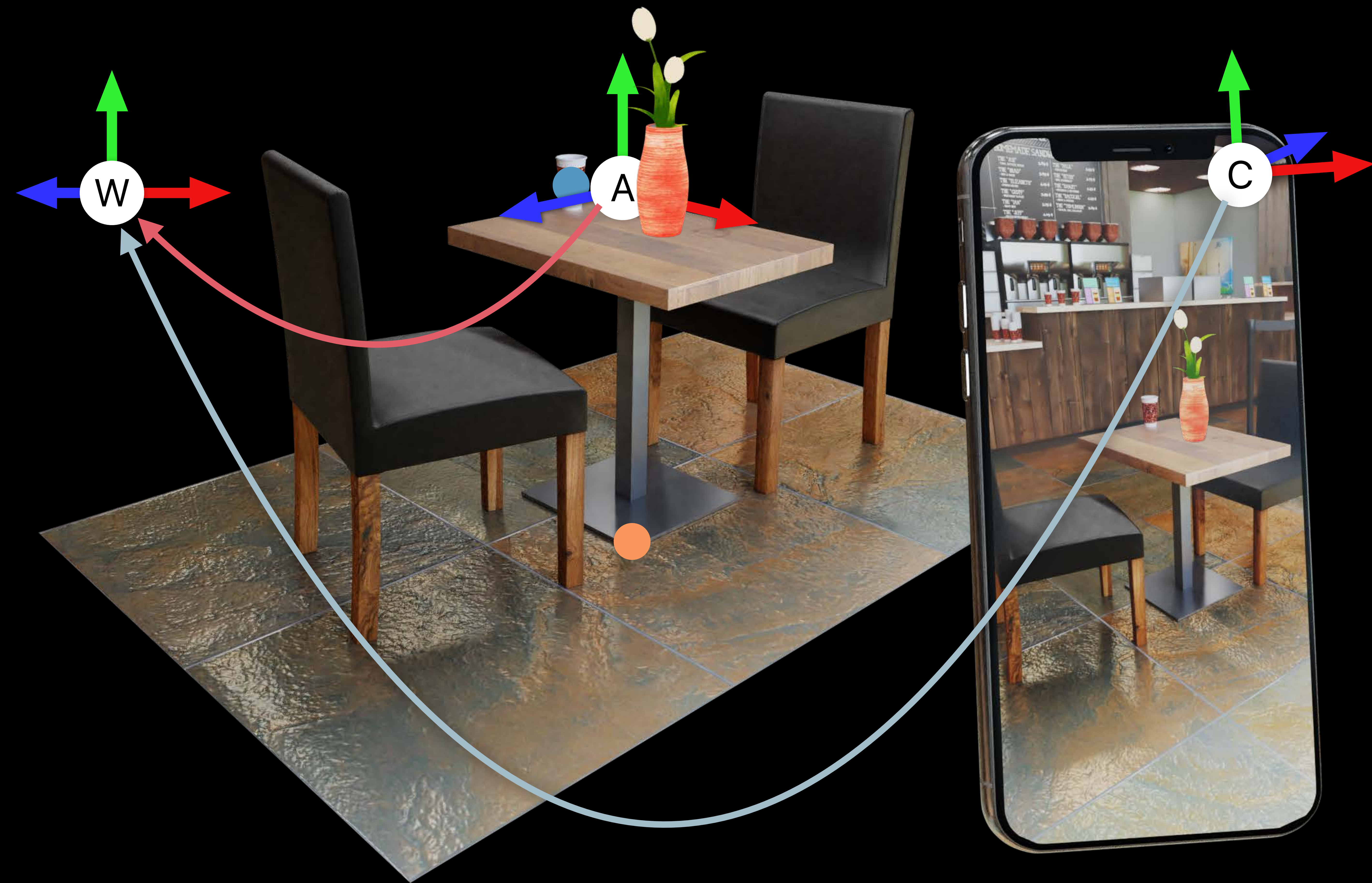
Behind the Scenes

Augmentation



Behind the Scenes

Augmentation



Behind the Scenes—Visual Inertial Odometry

Tracking



Behind the Scenes—Visual Inertial Odometry

Tracking



Behind the Scenes—Visual Inertial Odometry

Tracking



Behind the Scenes—Visual Inertial Odometry

Tracking



Behind the Scenes—Visual Inertial Odometry

Tracking



Behind the Scenes—Visual Inertial Odometry

Tracking



Behind the Scenes—Visual Inertial Odometry

Tracking



Behind the Scenes—Visual Inertial Odometry

Optimization for robust tracking



Behind the Scenes—Visual Inertial Odometry

Optimization for robust tracking



Behind the Scenes—Visual Inertial Odometry

Optimization for robust tracking



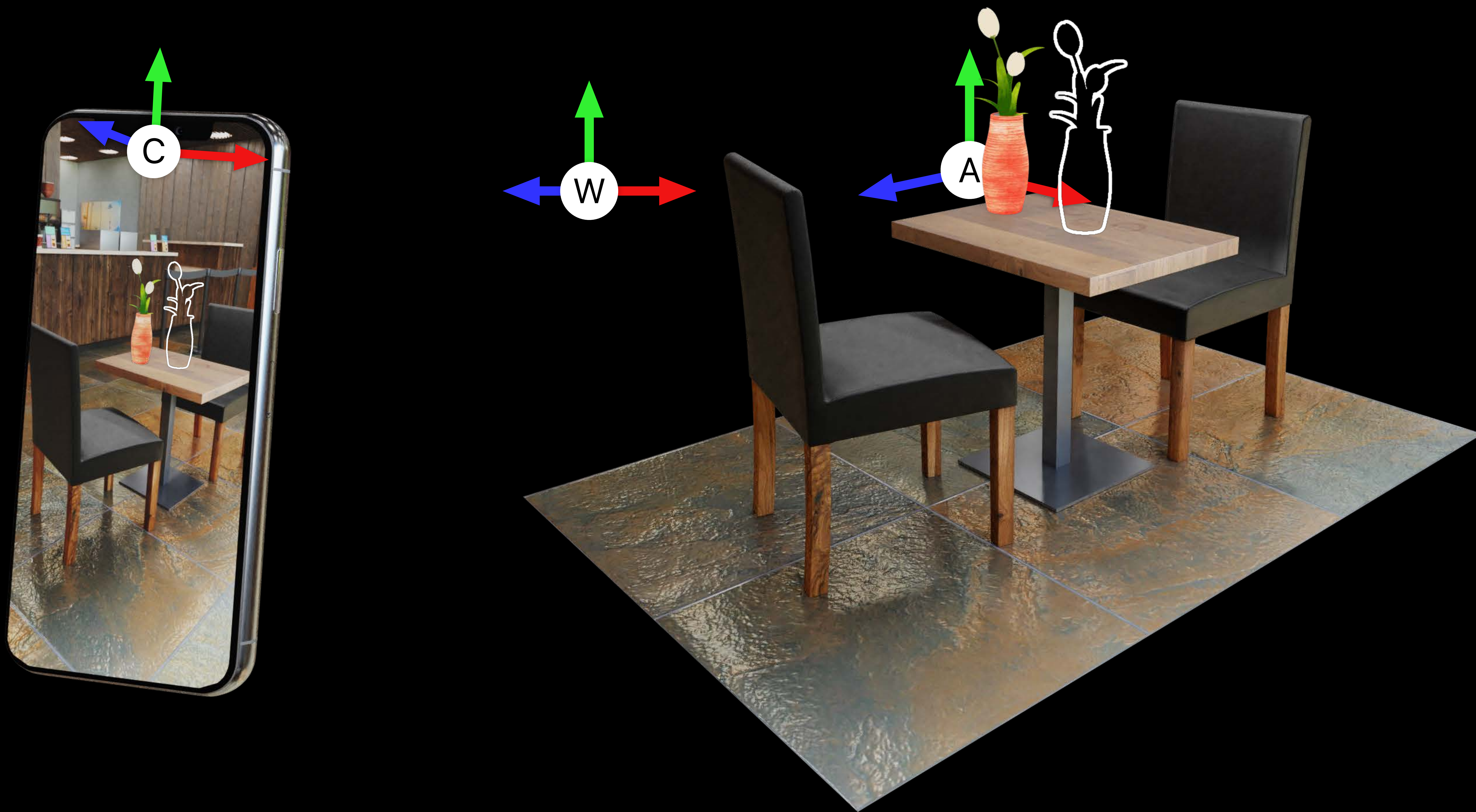
Behind the Scenes—Visual Inertial Odometry

Optimization for robust tracking



Behind the Scenes—Visual Inertial SLAM

Optimization for robust tracking



Behind the Scenes—Visual Inertial SLAM

Optimization for robust tracking



Behind the Scenes—Visual Inertial SLAM

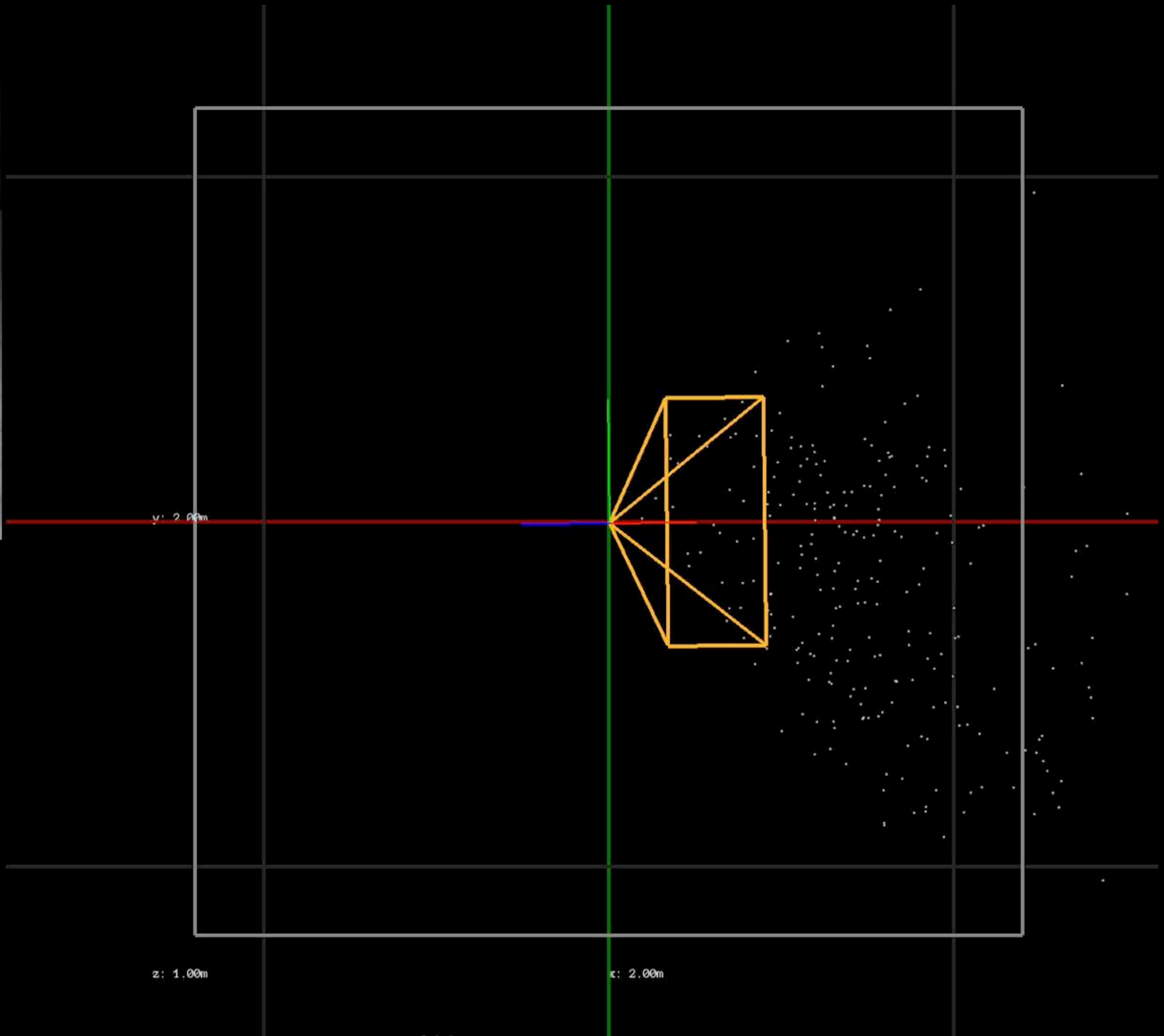
Optimization for robust tracking

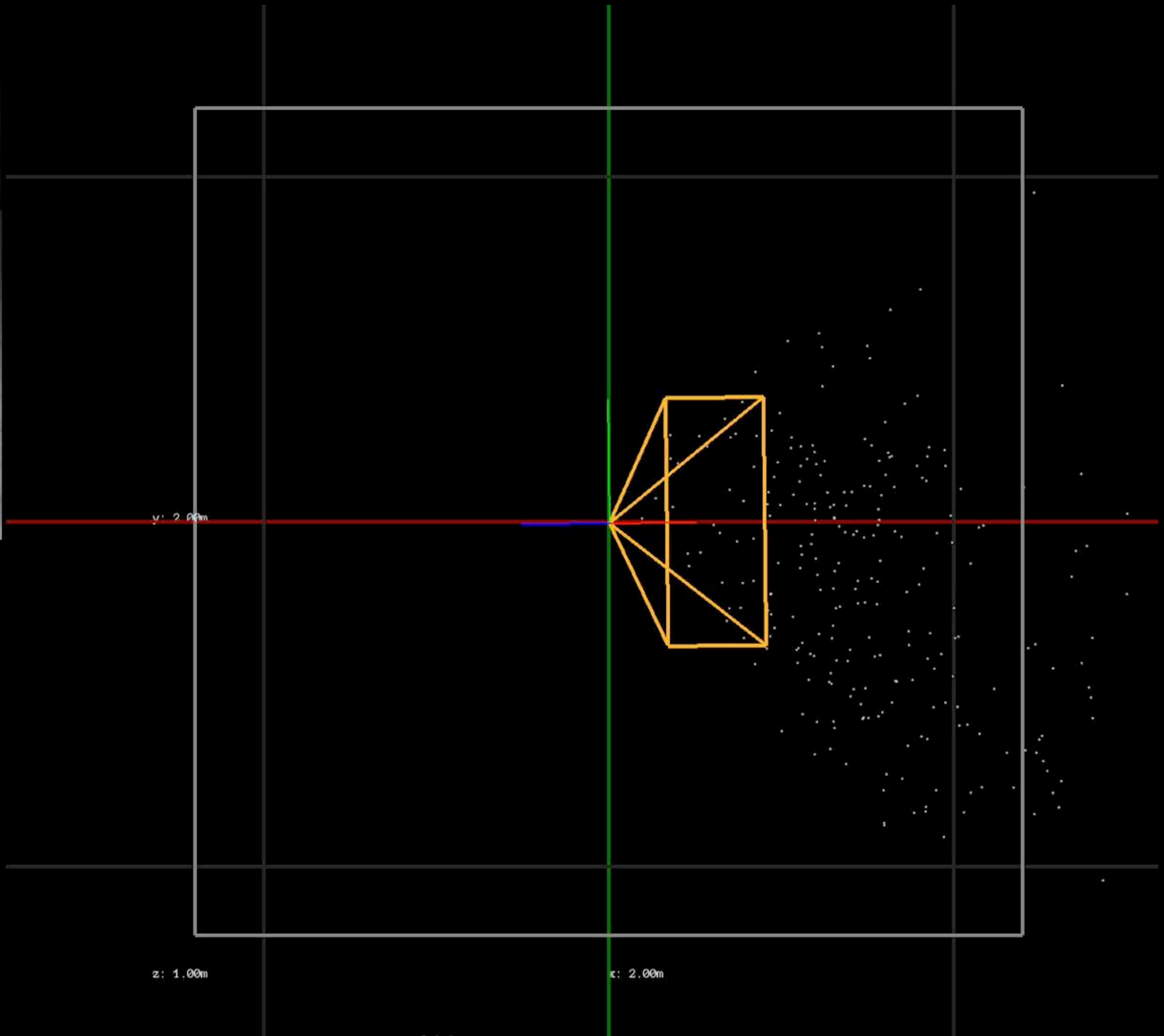


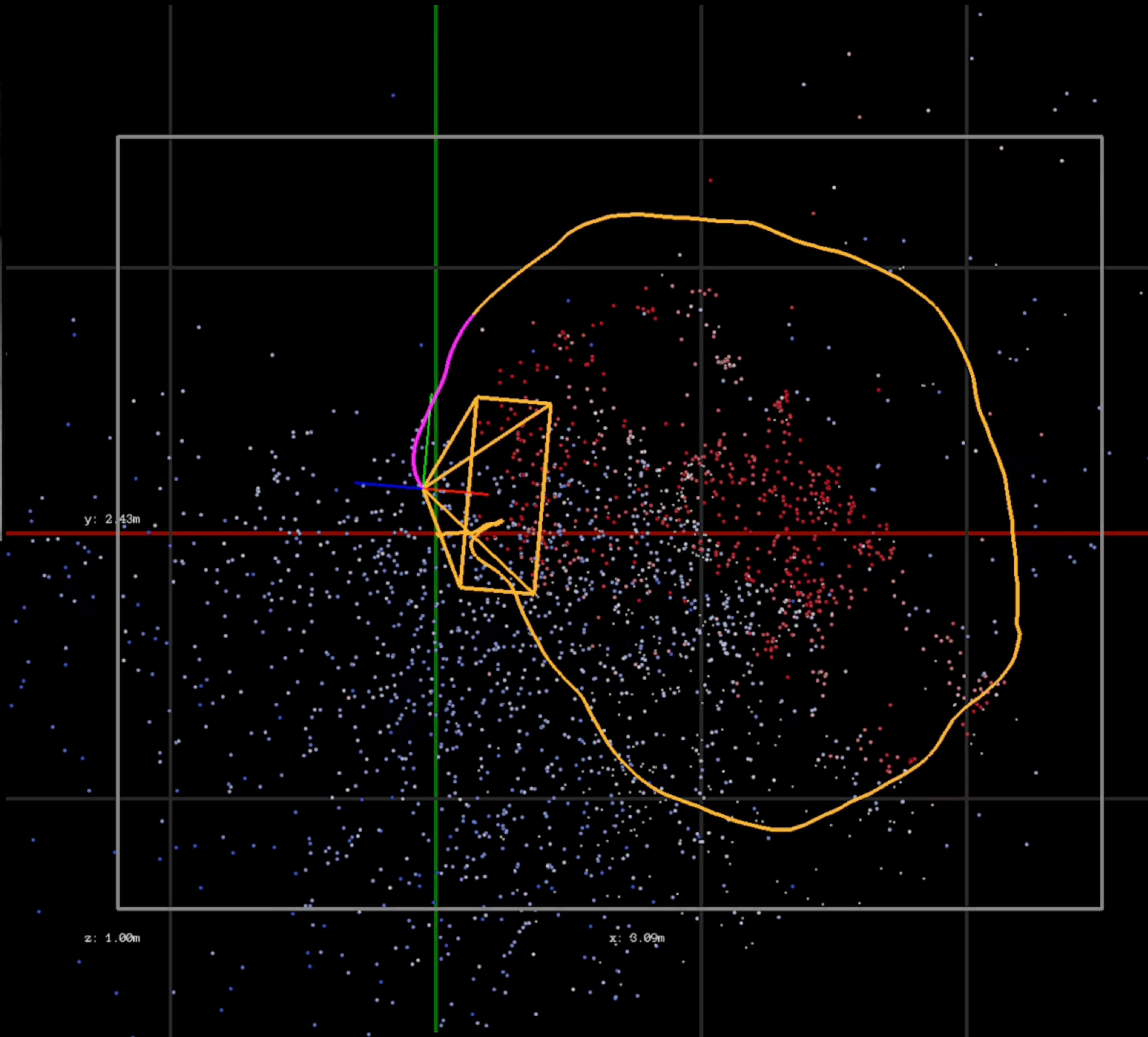
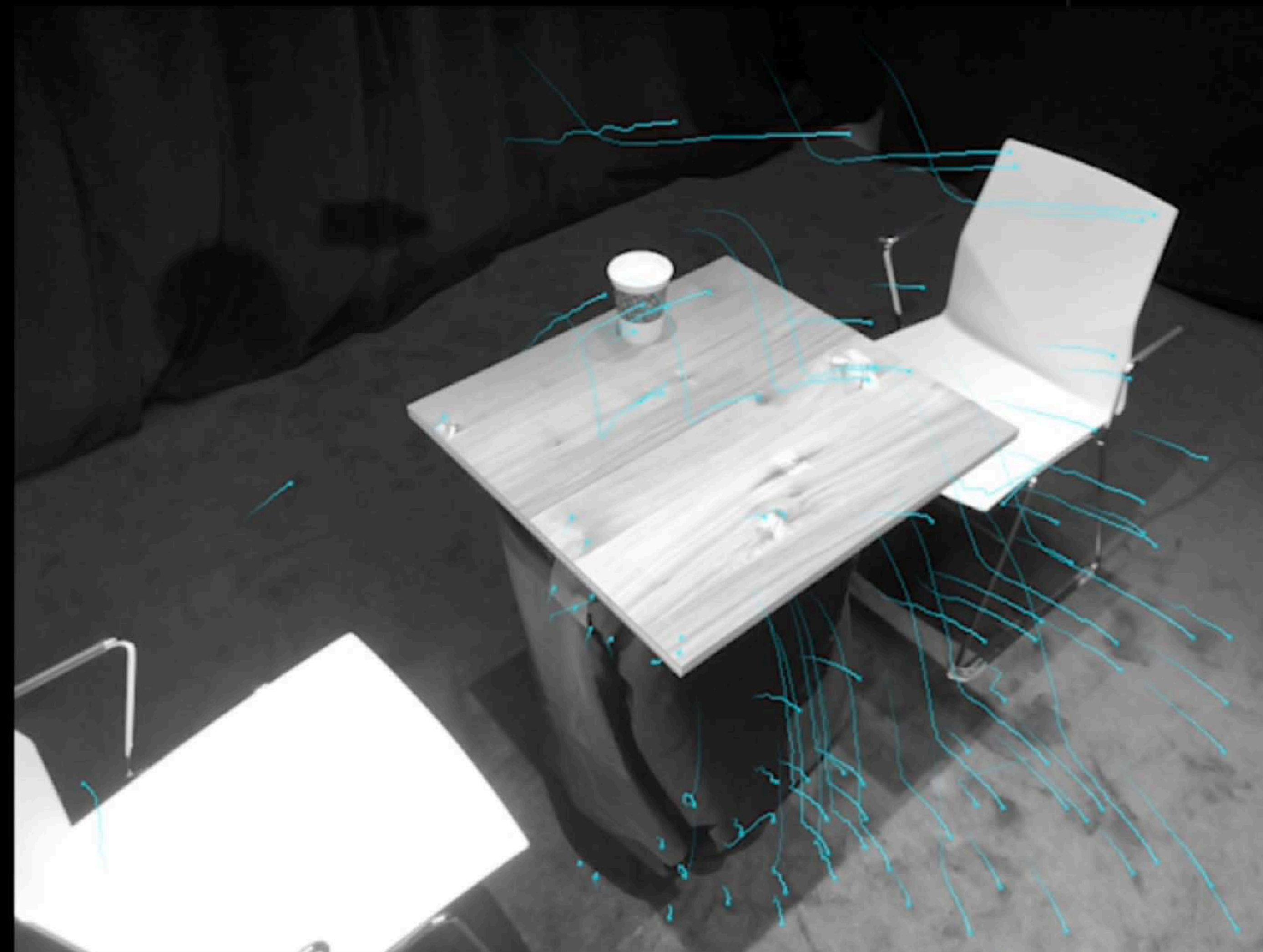
Behind the Scenes—Visual Inertial SLAM

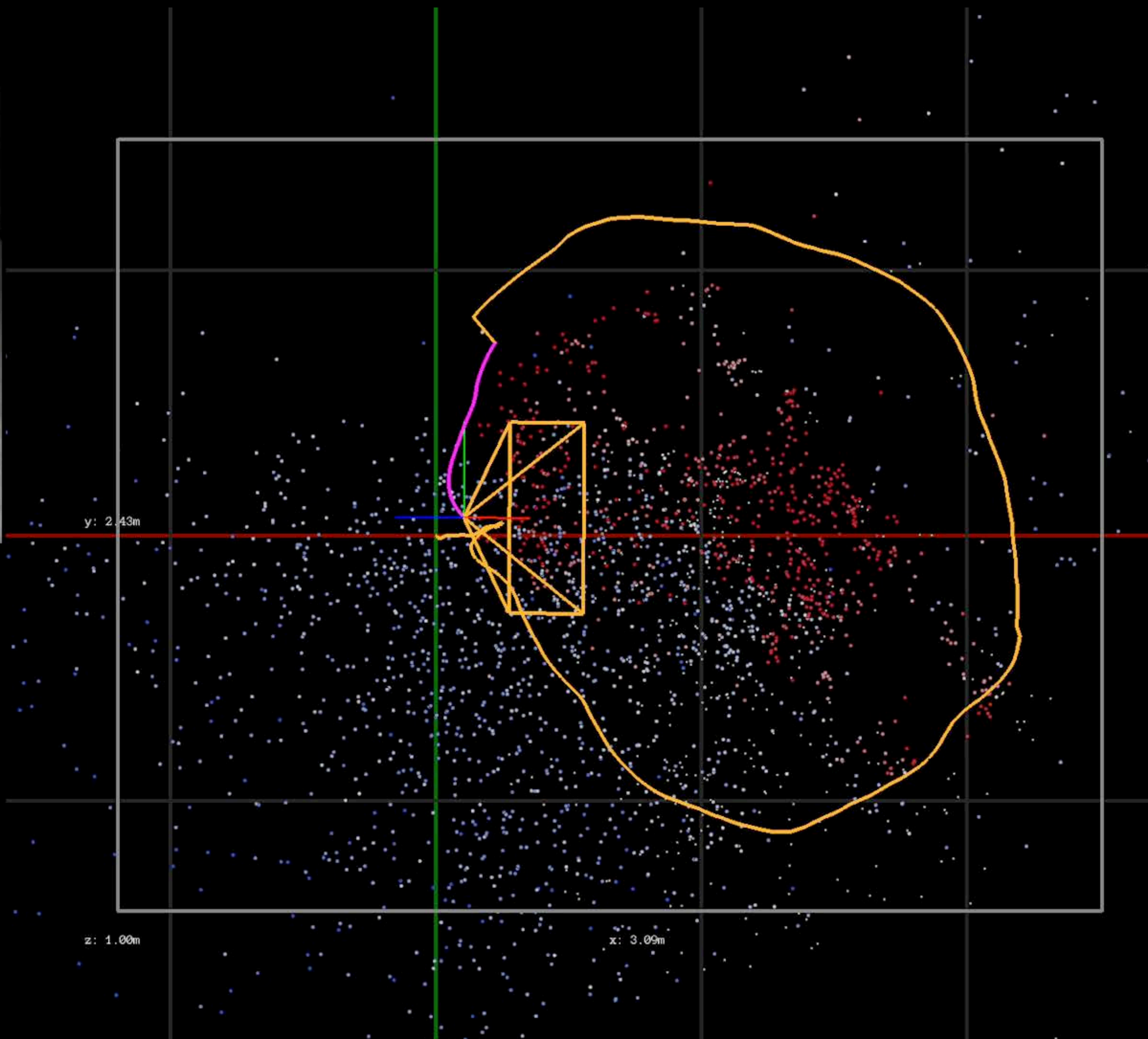
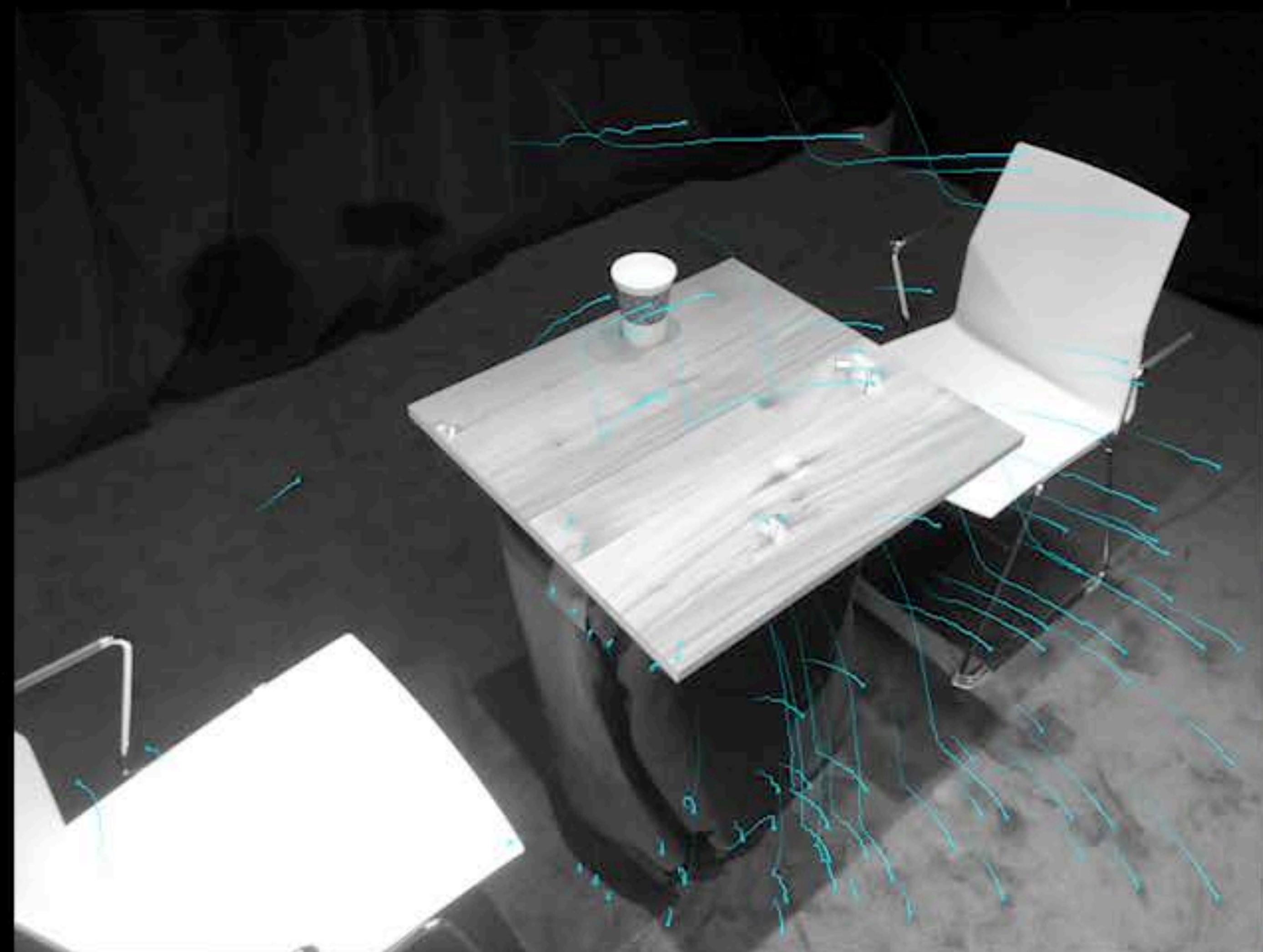
Optimization for robust tracking

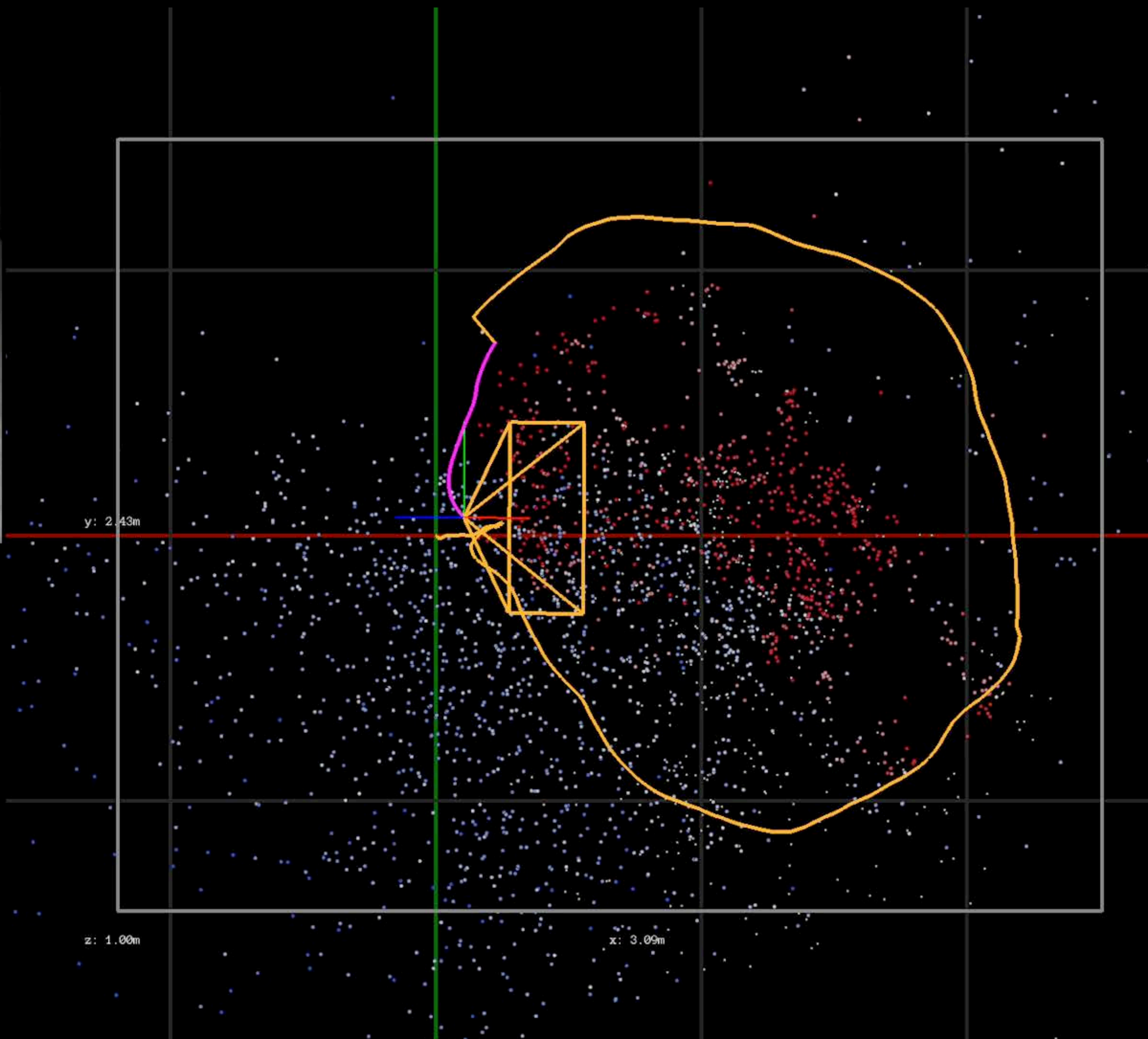
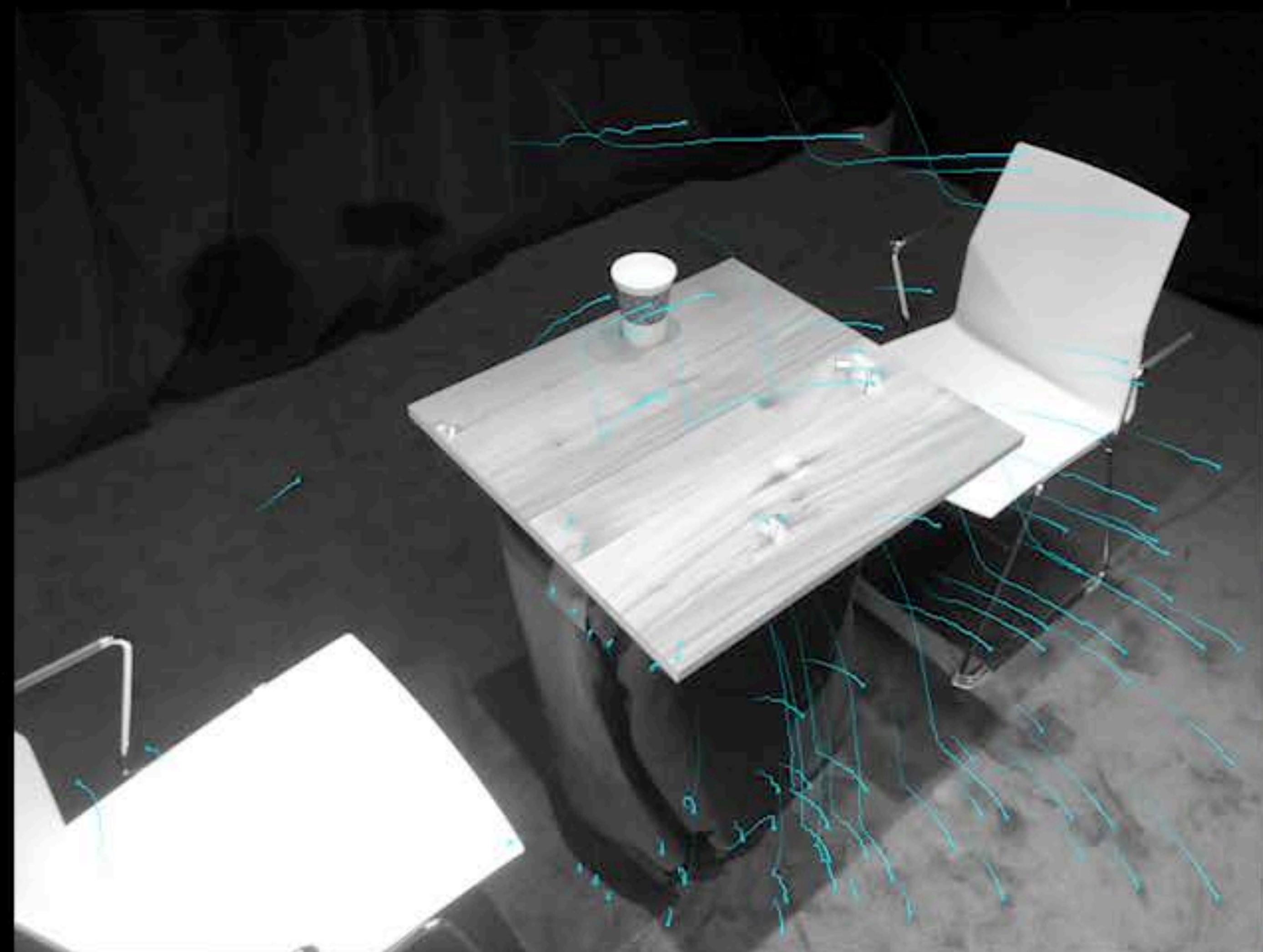






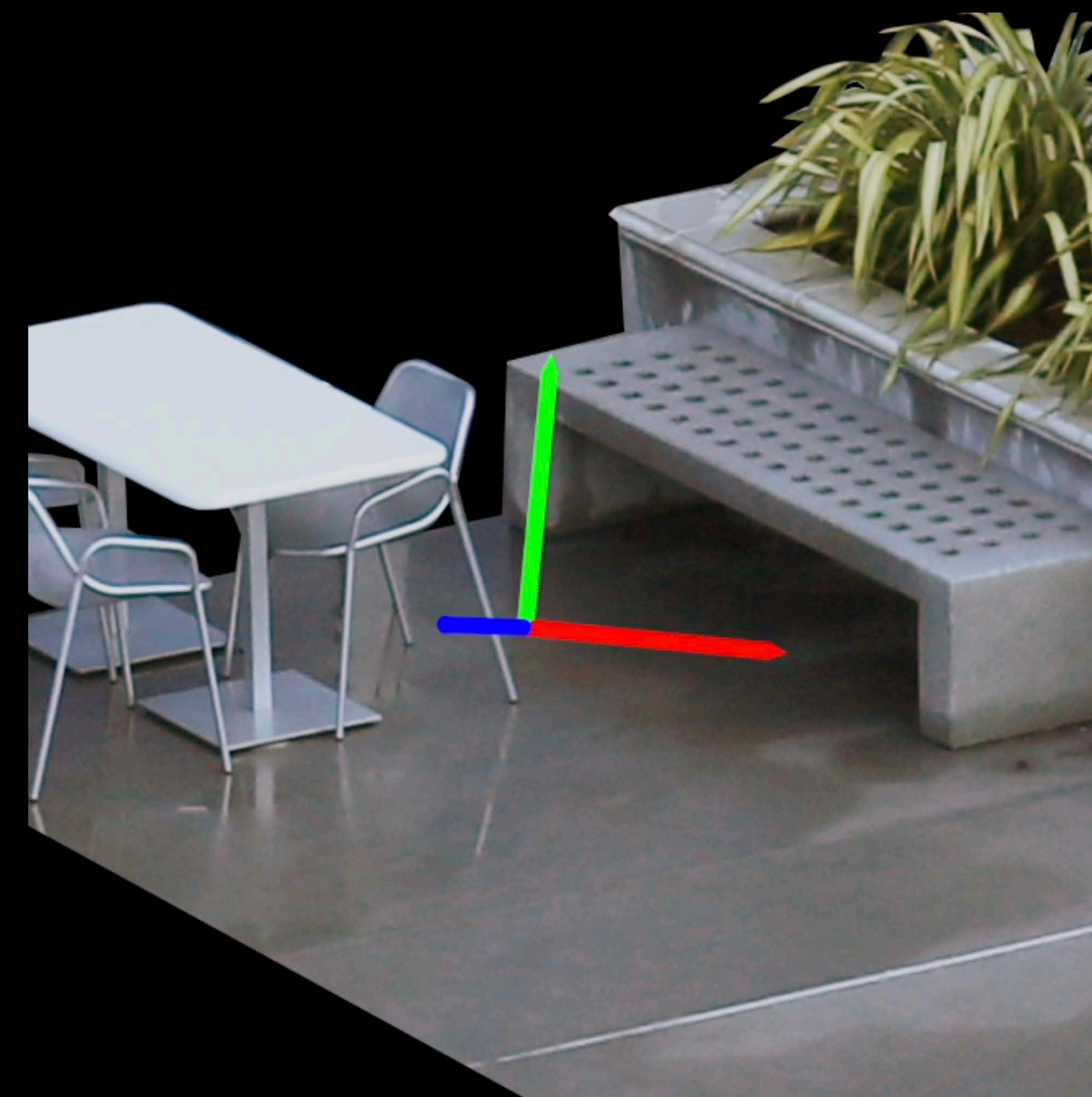






World Tracking API

ARWorldTrackingConfiguration



World Tracking API

```
ARWorldTrackingConfiguration
```

```
open class ARCamera : NSObject, NSCopying {
```

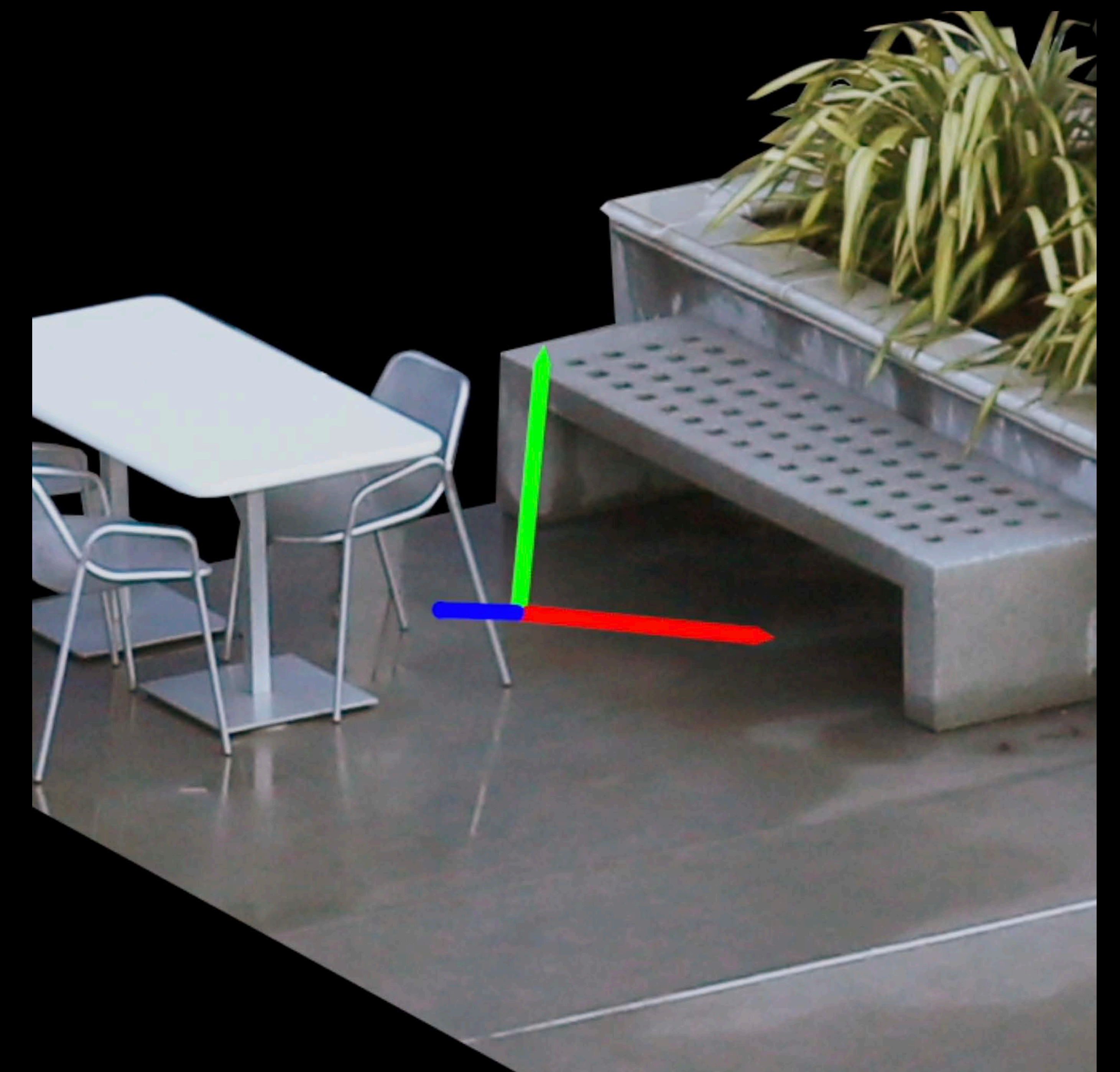
```
    open var transform: simd_float4x4 { get }
```

```
    open var trackingState: ARTrackingState { get }
```

```
    open var trackingStateReason: ARTrackingStateReason { get }
```

```
    ...
```

```
}
```



World Tracking API

```
ARWorldTrackingConfiguration
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```
open class ARCamera : NSObject, NSCopying {
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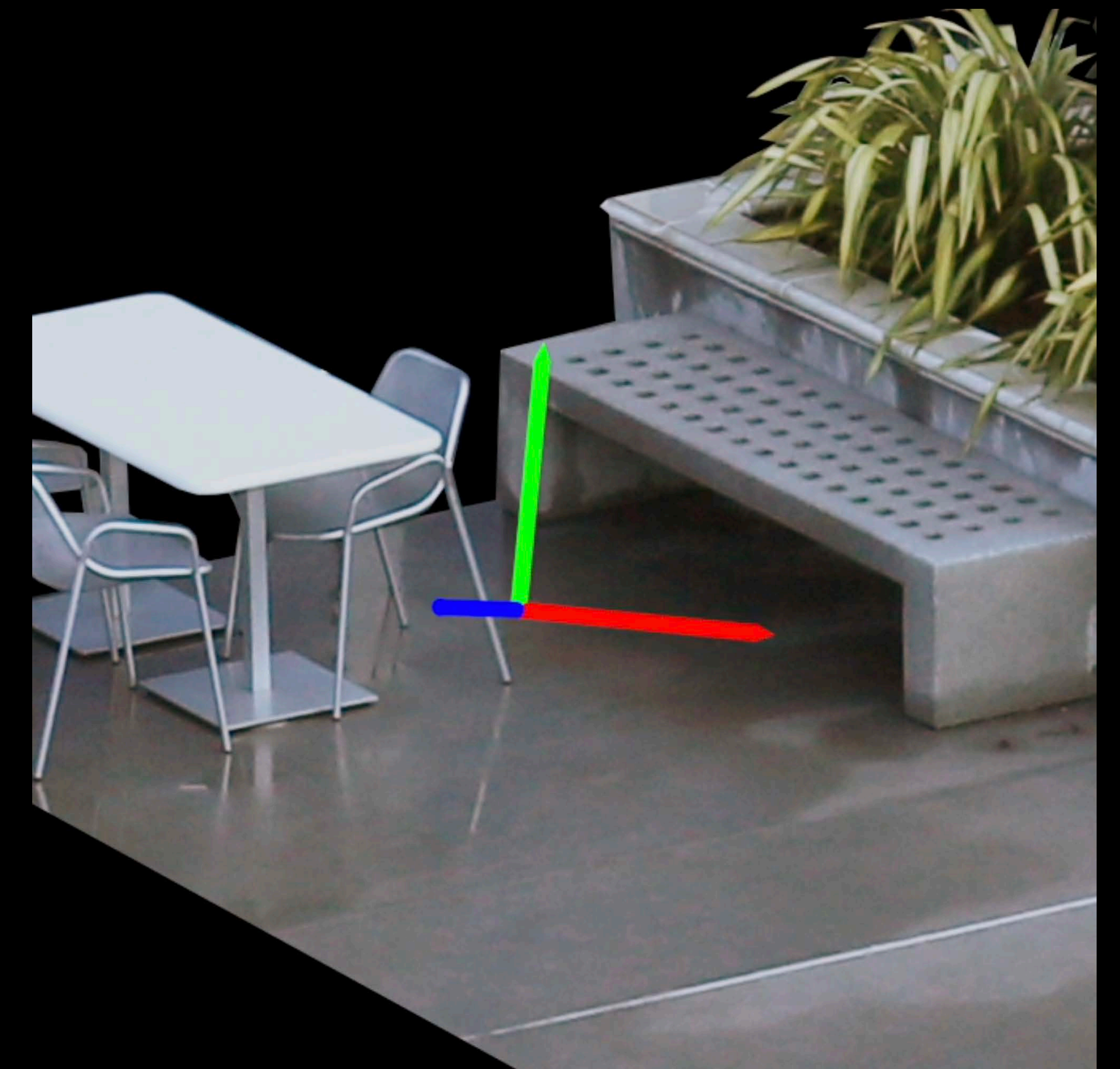
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World Tracking API

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ARWorldTrackingConfiguration
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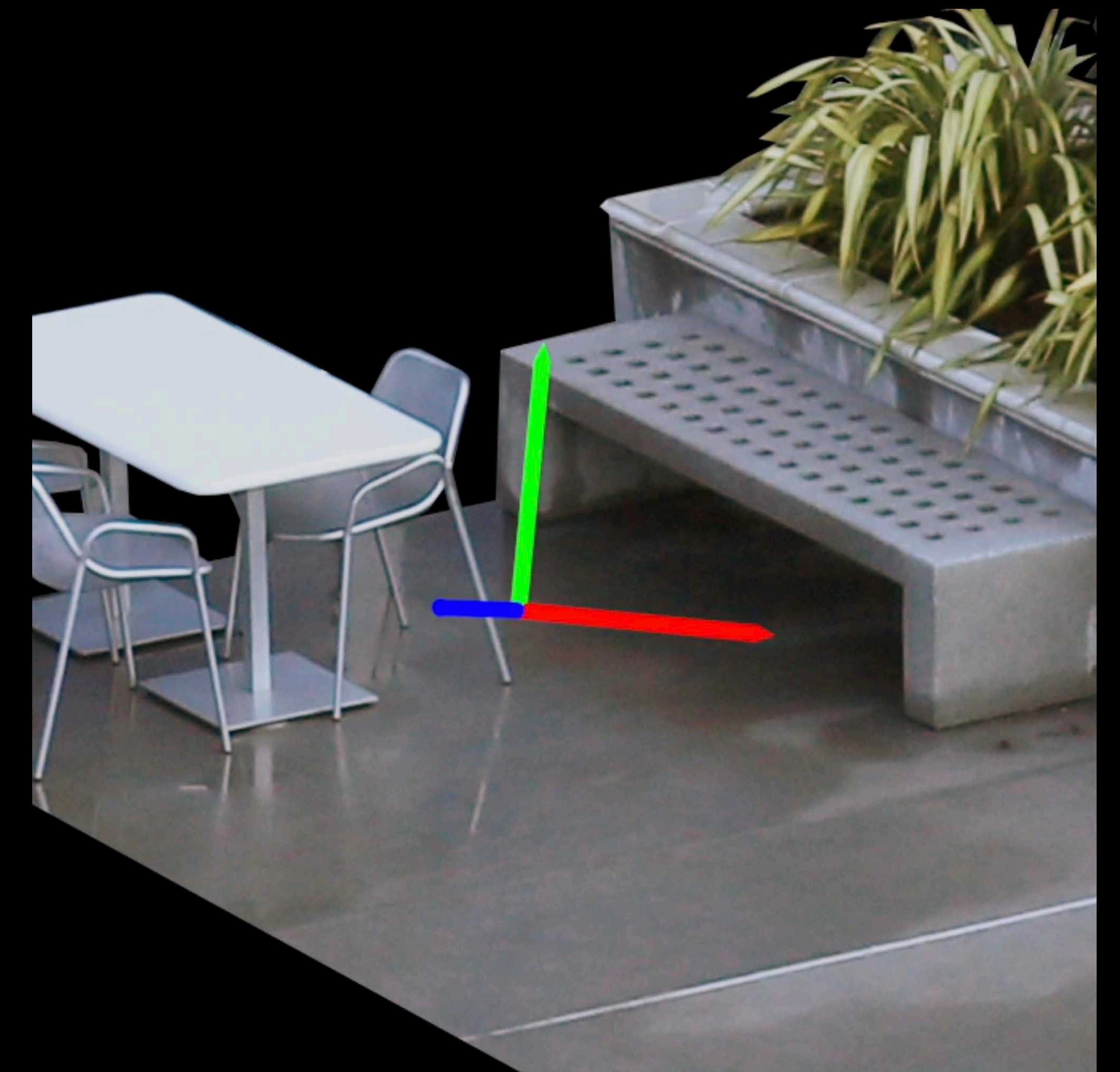
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```

```
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```



World Tracking Quality

Uninterrupted sensor data

World Tracking Quality

Uninterrupted sensor data

Textured environments



World Tracking Quality

Uninterrupted sensor data

Textured environments



World Tracking Quality

Uninterrupted sensor data

Textured environments

Static scenes



World Tracking Quality

Uninterrupted sensor data

Textured environments

Static scenes



World Tracking Quality—Behind the Scenes

“Health Monitoring”



Health estimate: 0.392

Speed: 0.28 Km/h

World Tracking Quality—Behind the Scenes

“Health Monitoring”



Health estimate: 0.392

Speed: 0.28 Km/h

Tracking State



Tracking State



```
// Called when tracking state changed
func session(_ session: ARSession, cameraDidChangeTrackingState camera: ARCamera) {
    if case .limited(let reason) = camera.trackingState {
        // Guide user to improve tracking state
        ...
    }
}
```


Tracking State



```
// Called when tracking state changed
func session(_ session: ARSession, cameraDidChangeTrackingState camera: ARCamera) {
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World Tracking

Take-aways

Tracks orientation and position (6 DoF)



World Tracking

Take-aways

Tracks orientation and position (6 DoF)



World Tracking

Take-aways

Tracks orientation and position (6 DoF)

Augmentation into your physical world



World Tracking

Take-aways

Tracks orientation and position (6 DoF)

Augmentation into your physical world

World Map



World Tracking

Take-aways

Tracks orientation and position (6 DoF)

Augmentation into your physical world

World Map

Guide user to achieve best tracking quality



World Tracking

Take-aways

Tracks orientation and position (6 DoF)

Augmentation into your physical world

World Map

Guide user to achieve best tracking quality

Runs on your device only



World Tracking

Take-aways

Tracks orientation and position (6 DoF)

Augmentation into your physical world

World Map

Guide user to achieve best tracking quality

Runs on your device only

“Building Your First AR Experience”



Plane Detection





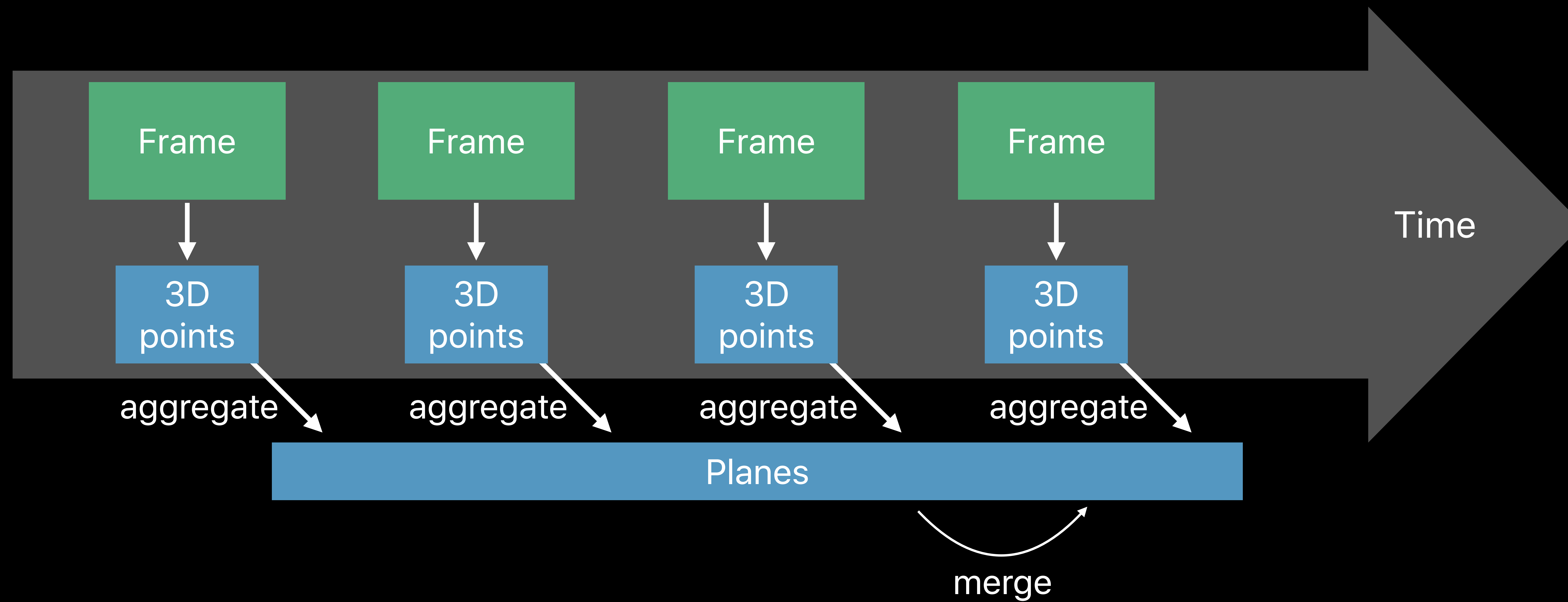








Behind the Scenes

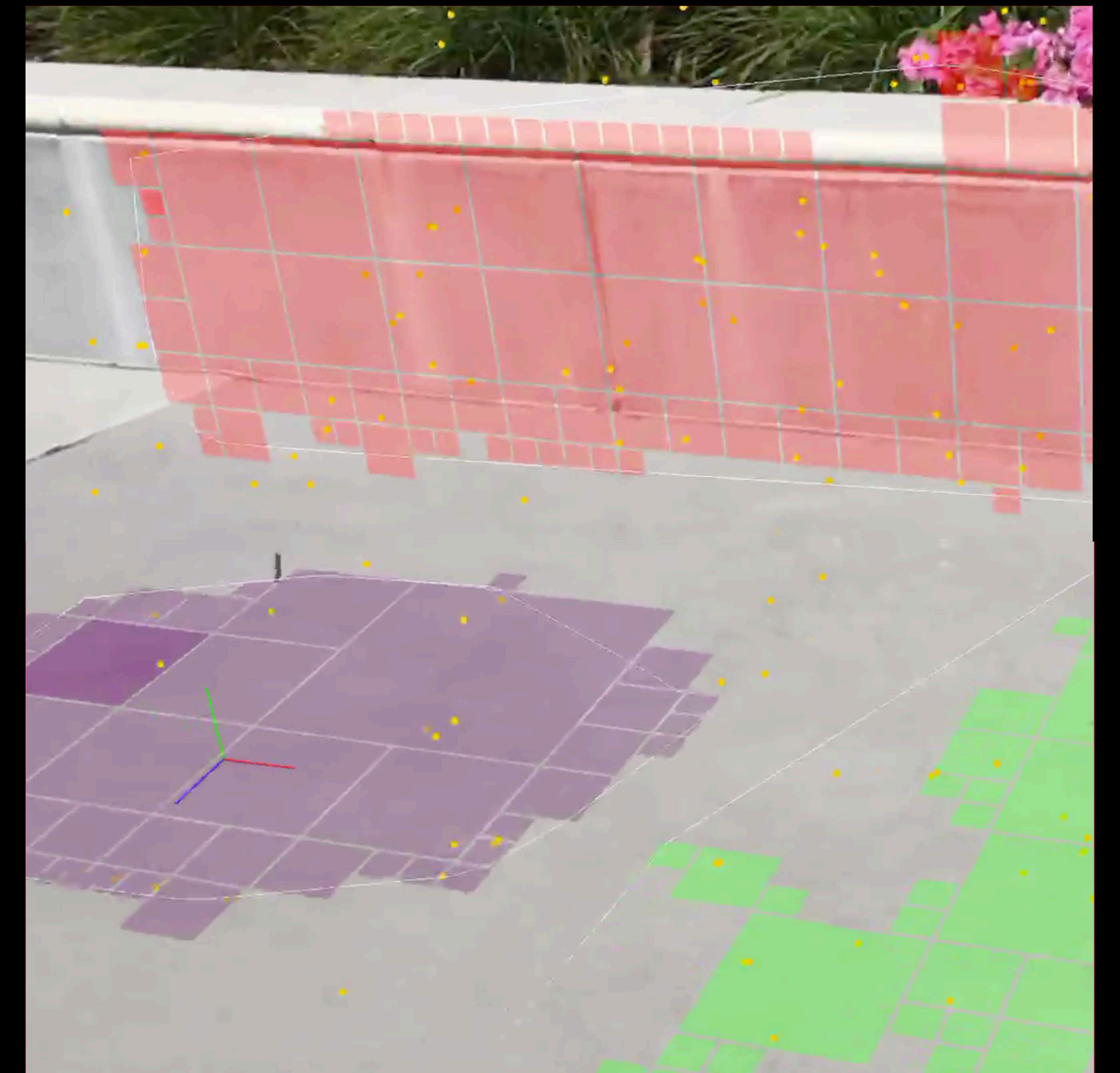


Plane Detection API

```
// Create a world tracking configuration
let configuration = ARWorldTrackingConfiguration()

// Enable plane detection
configuration.planeDetection = [.horizontal, .vertical]

// Run the session
session.run(configuration)
```

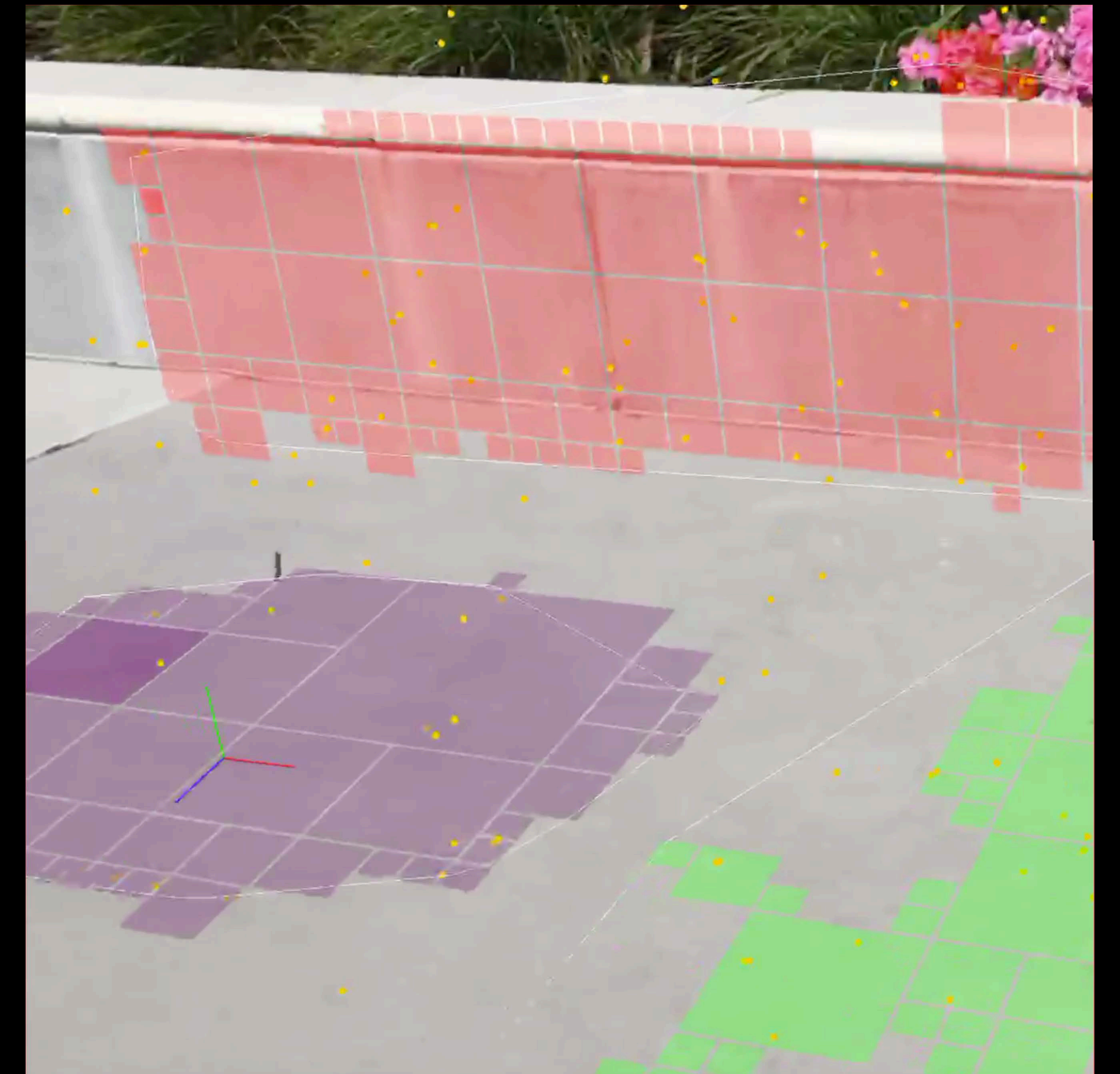


Plane Detection API

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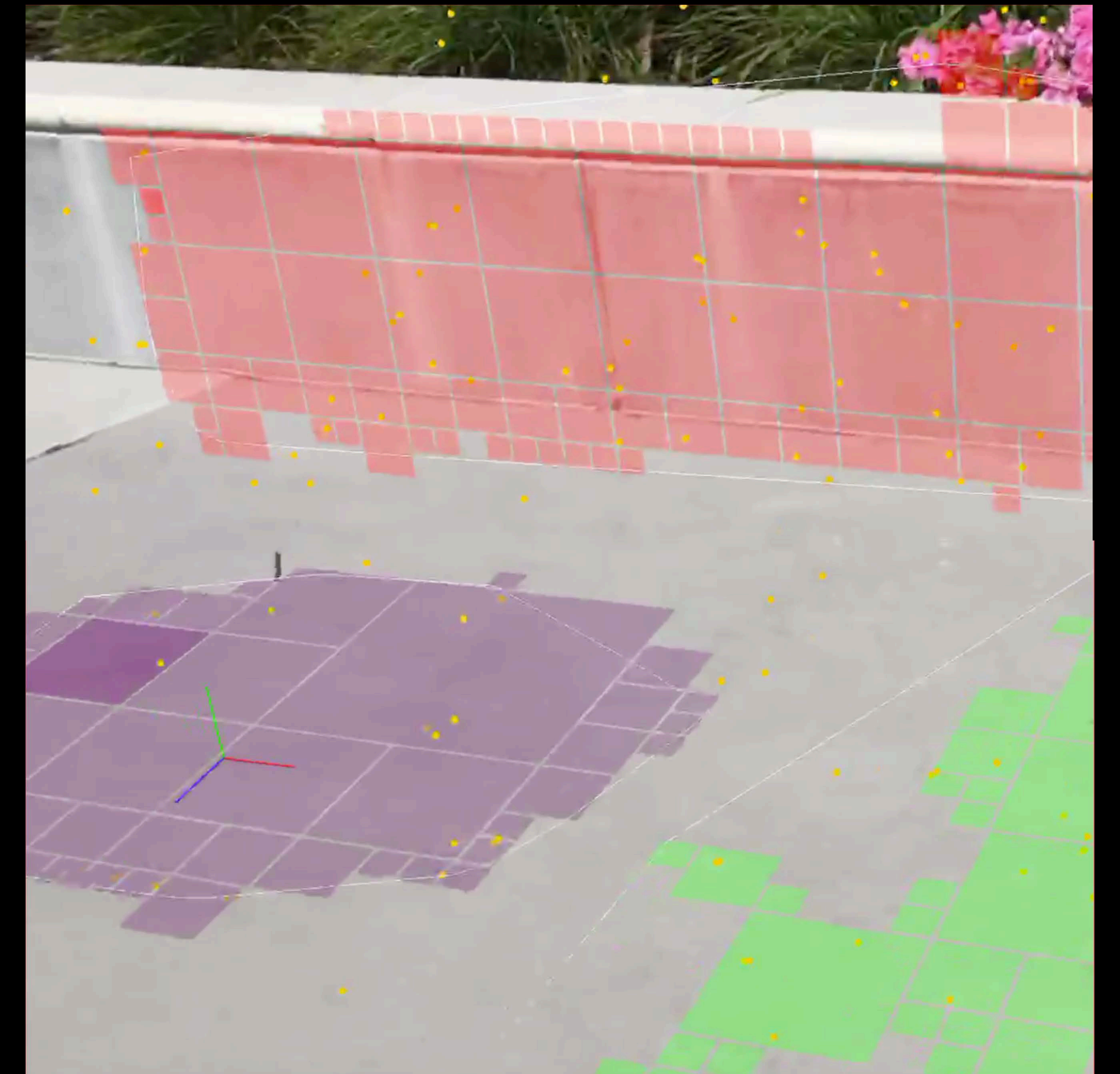


Plane Detection API

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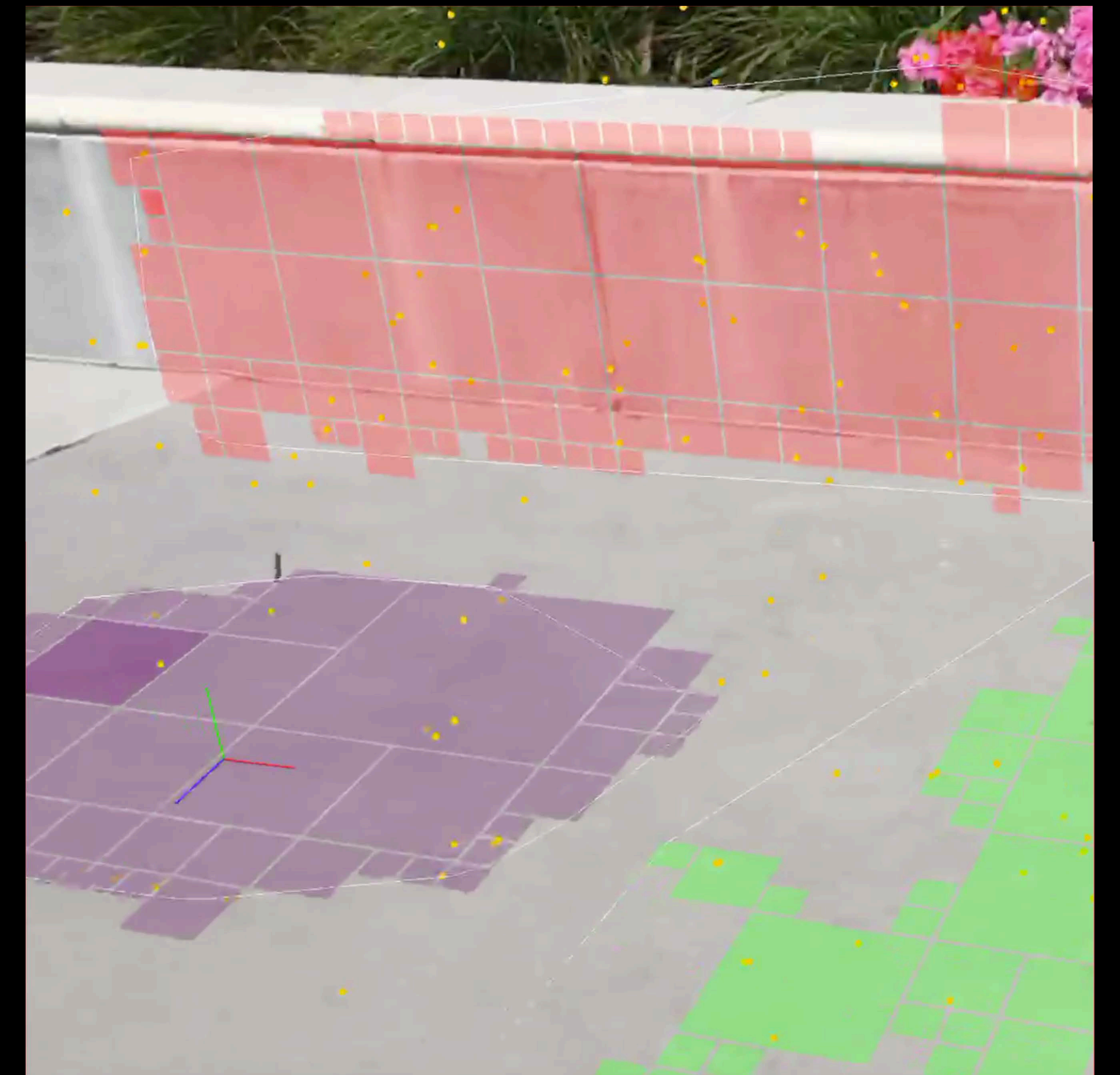
// Enable plane detection
configuration.planeDetection = [.horizontal, .vertical]

// Run the session
session.run(configuration)
```



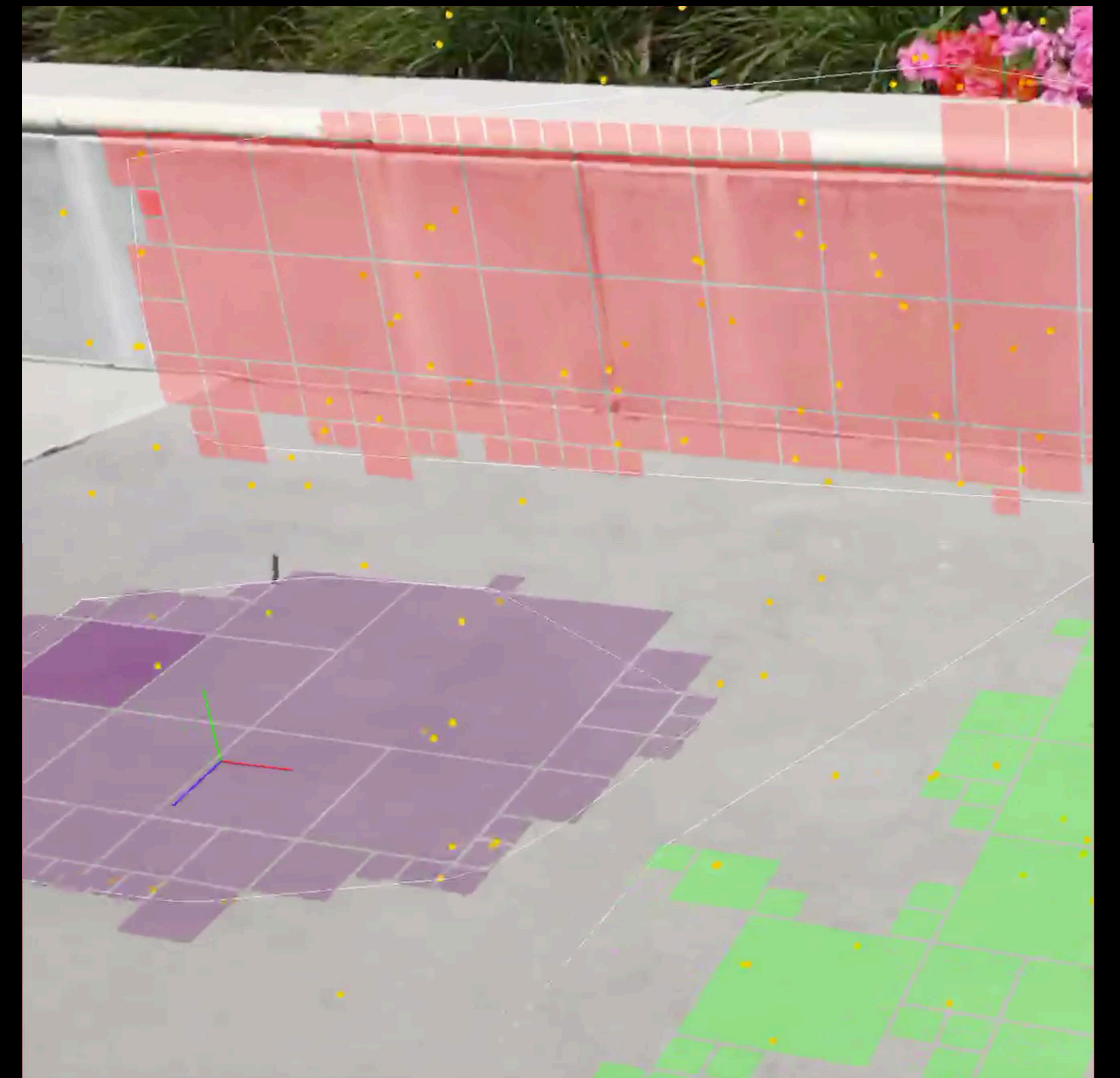
Plane Detection API

```
open class ARPlaneAnchor : ARAnchor {  
  
    open var transform: simd_float4x4 { get }  
  
    open var center: simd_float3 { get }  
    open var extent: simd_float3 { get }  
  
    open var geometry: ARPlaneGeometry { get }  
    ...  
}
```



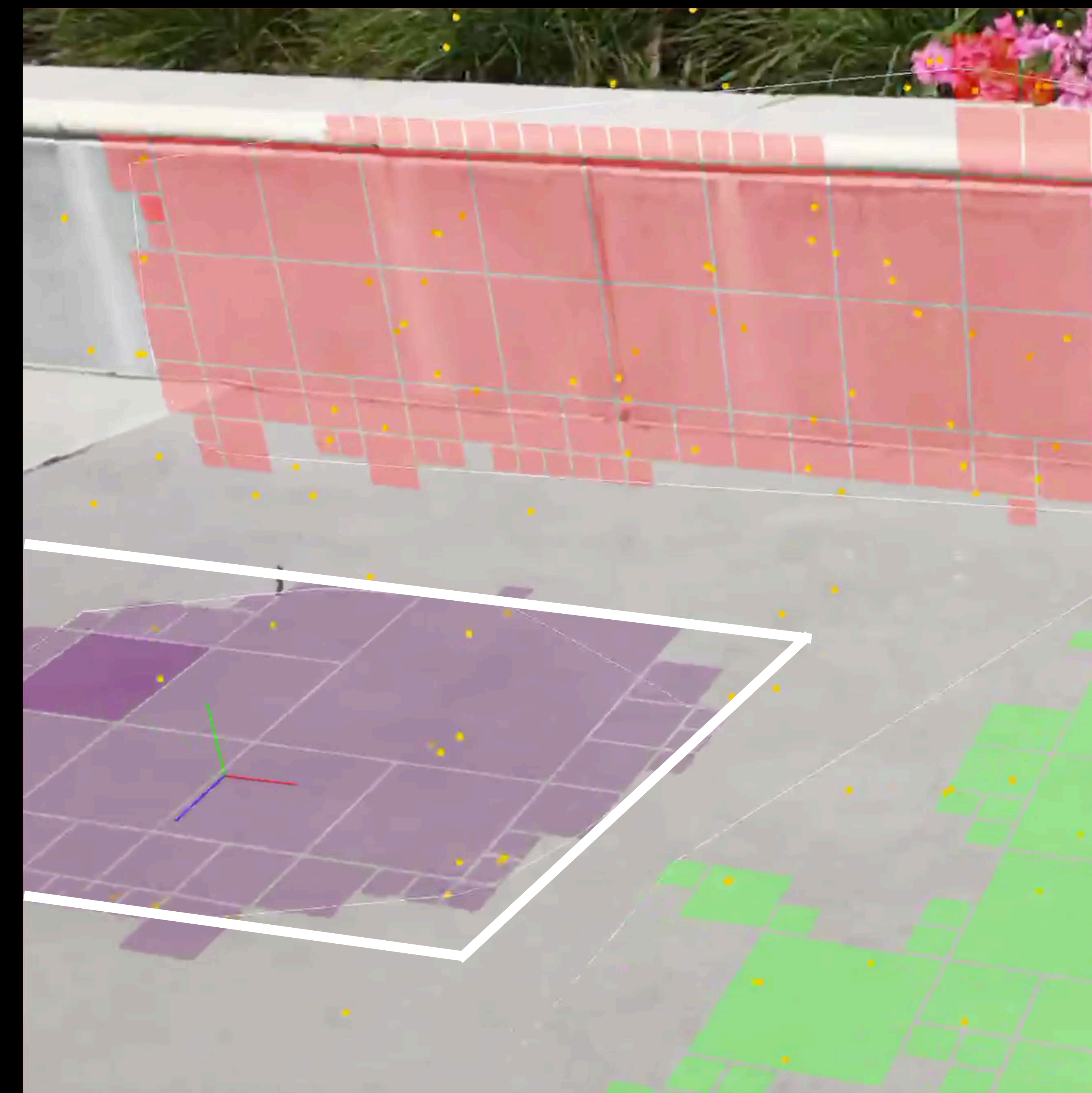
Plane Detection API

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    ...  
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```



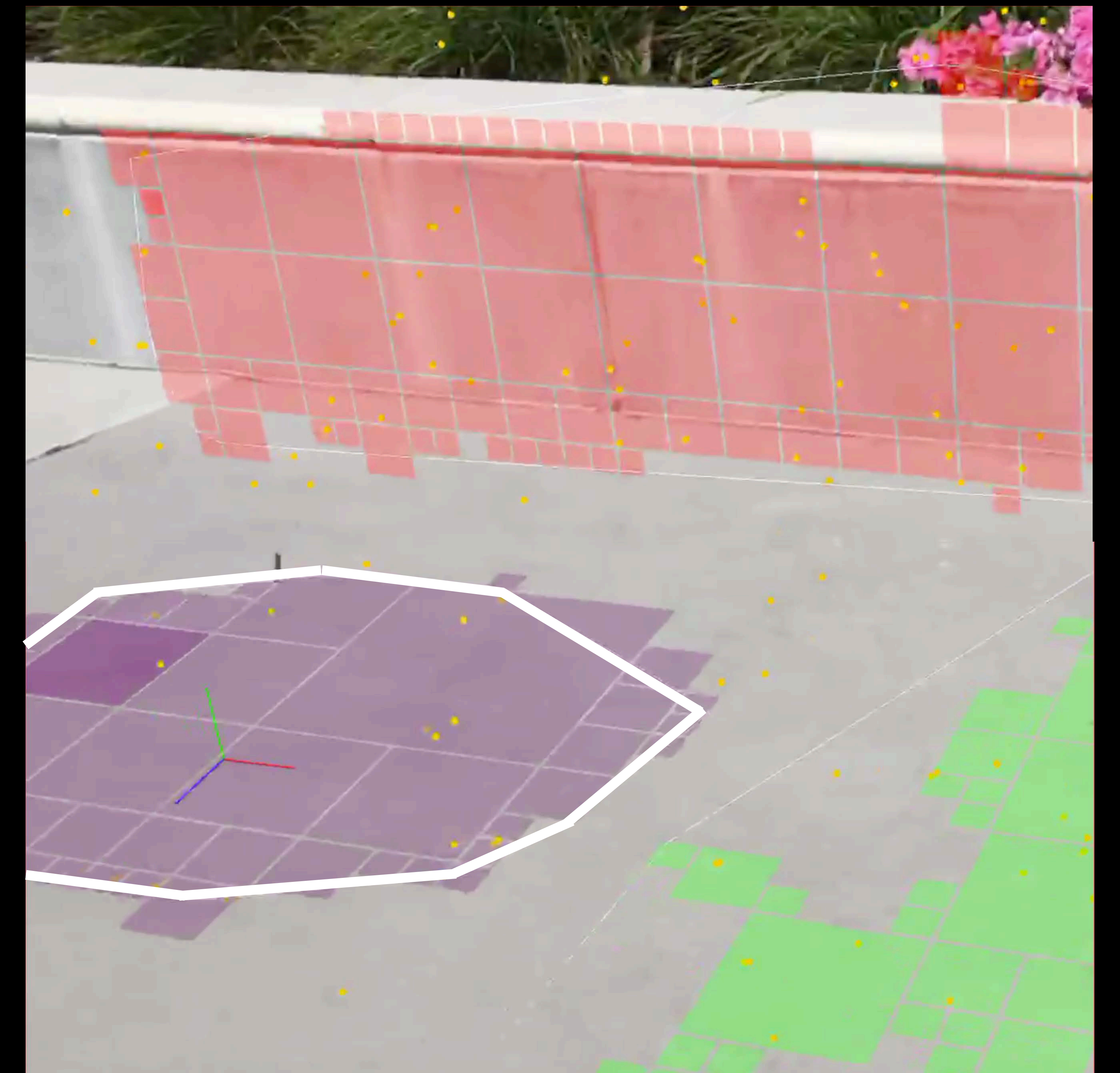
Plane Detection API

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    ...  
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```



Plane Detection API

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open class ARPlaneAnchor : ARAnchor {  
  
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    open var geometry: ARPlaneGeometry { get }  
    ...  
}
```





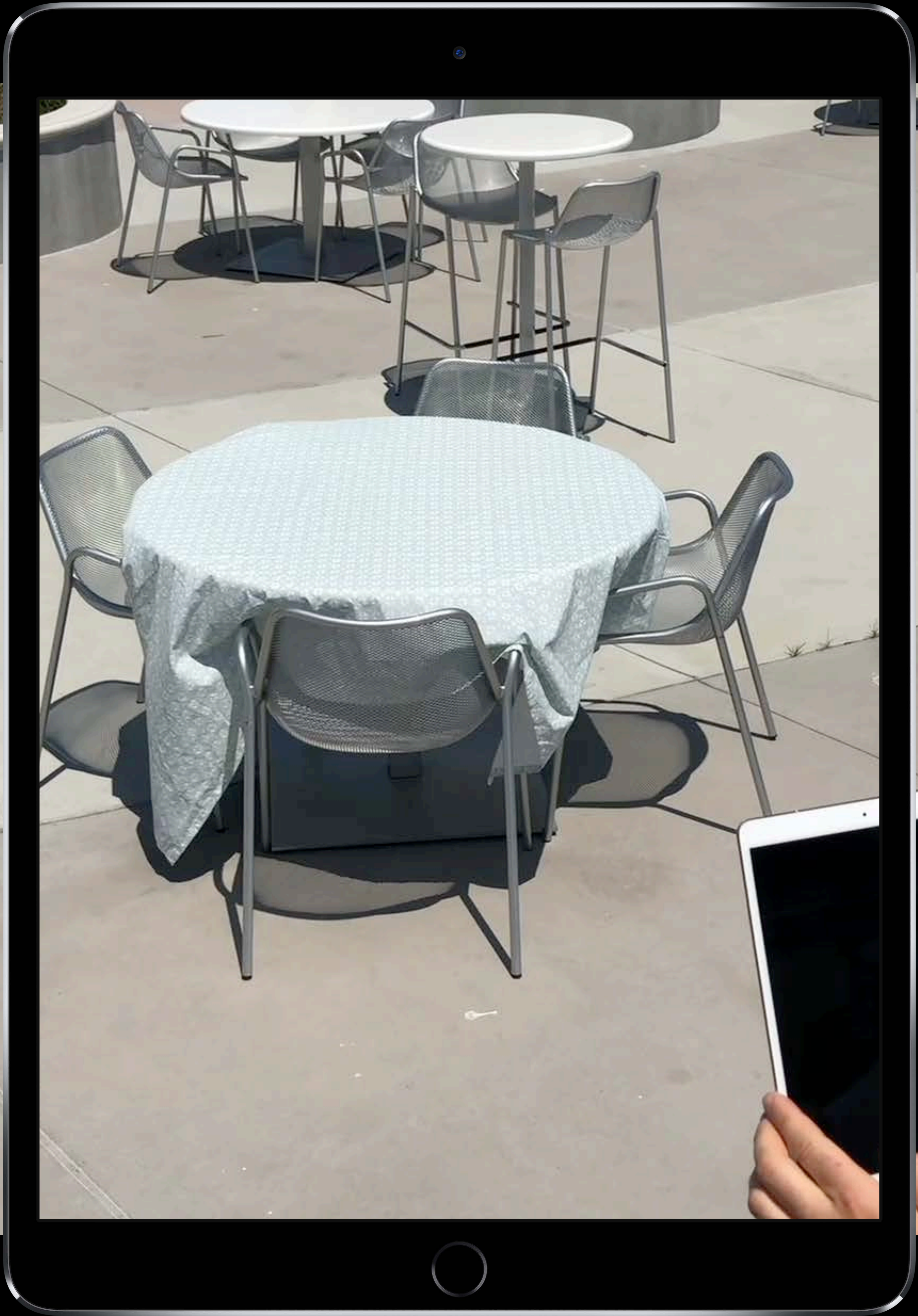




Saving and Loading Maps

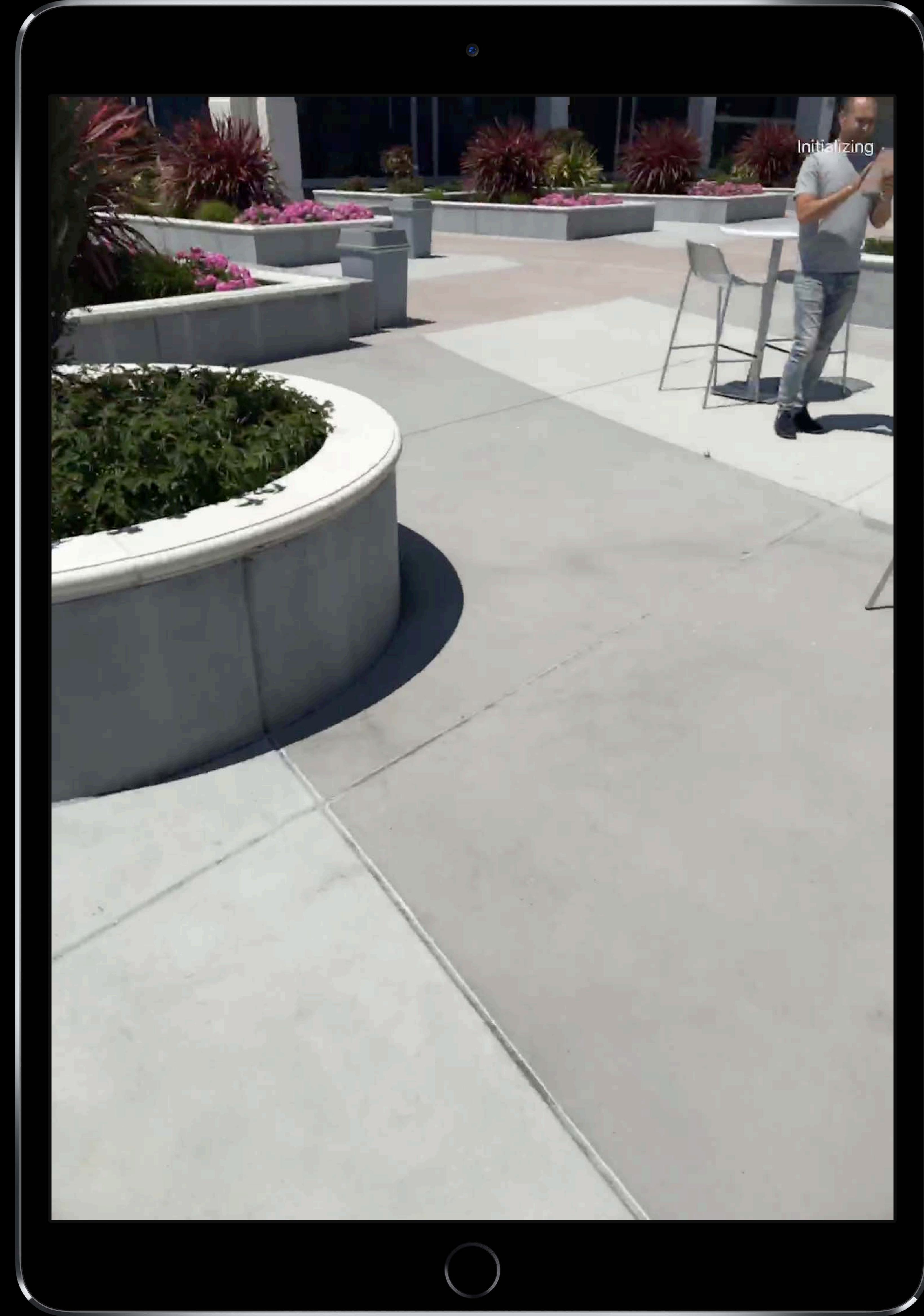
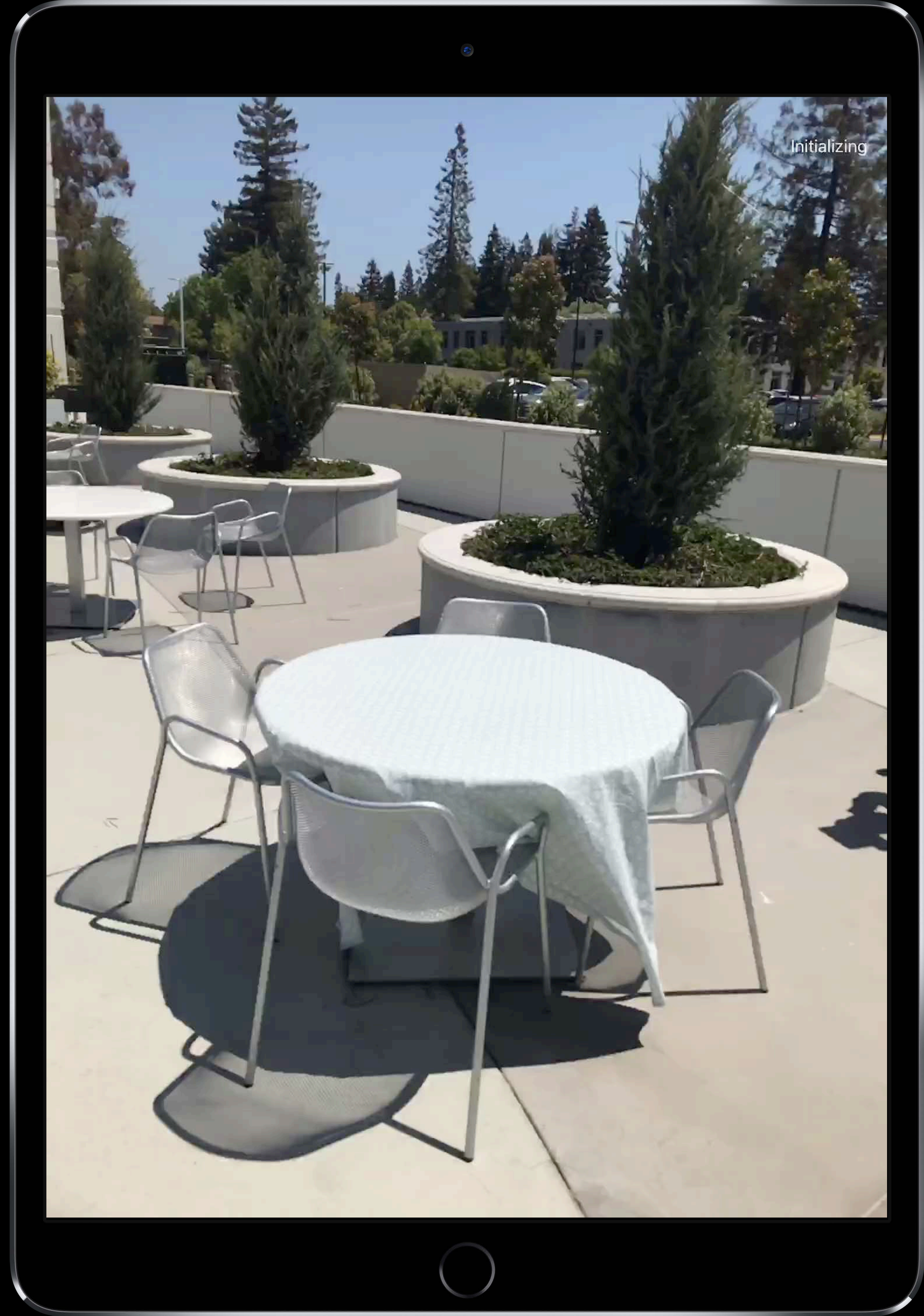
Michele Stoppa, ARKit Engineering

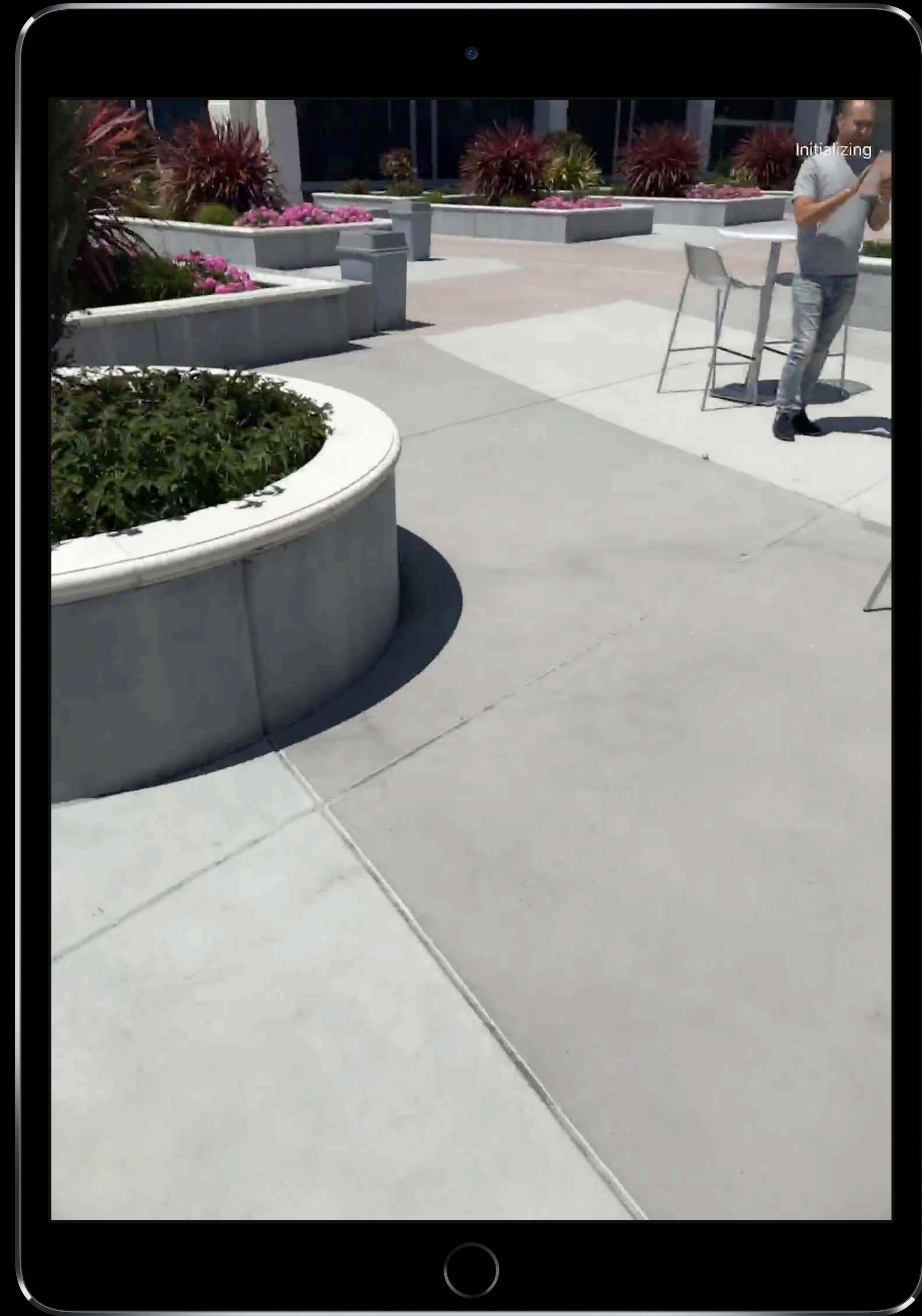




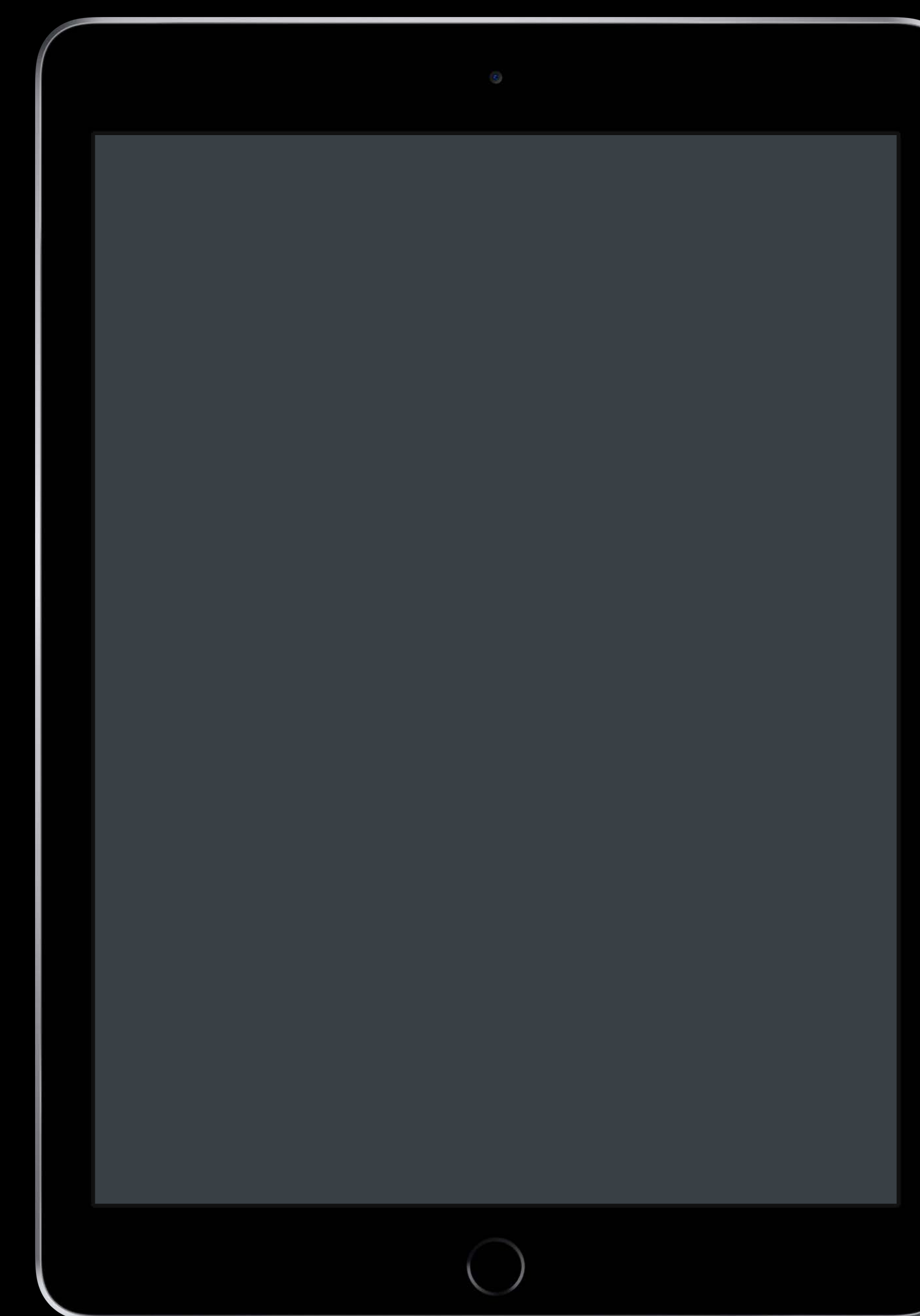






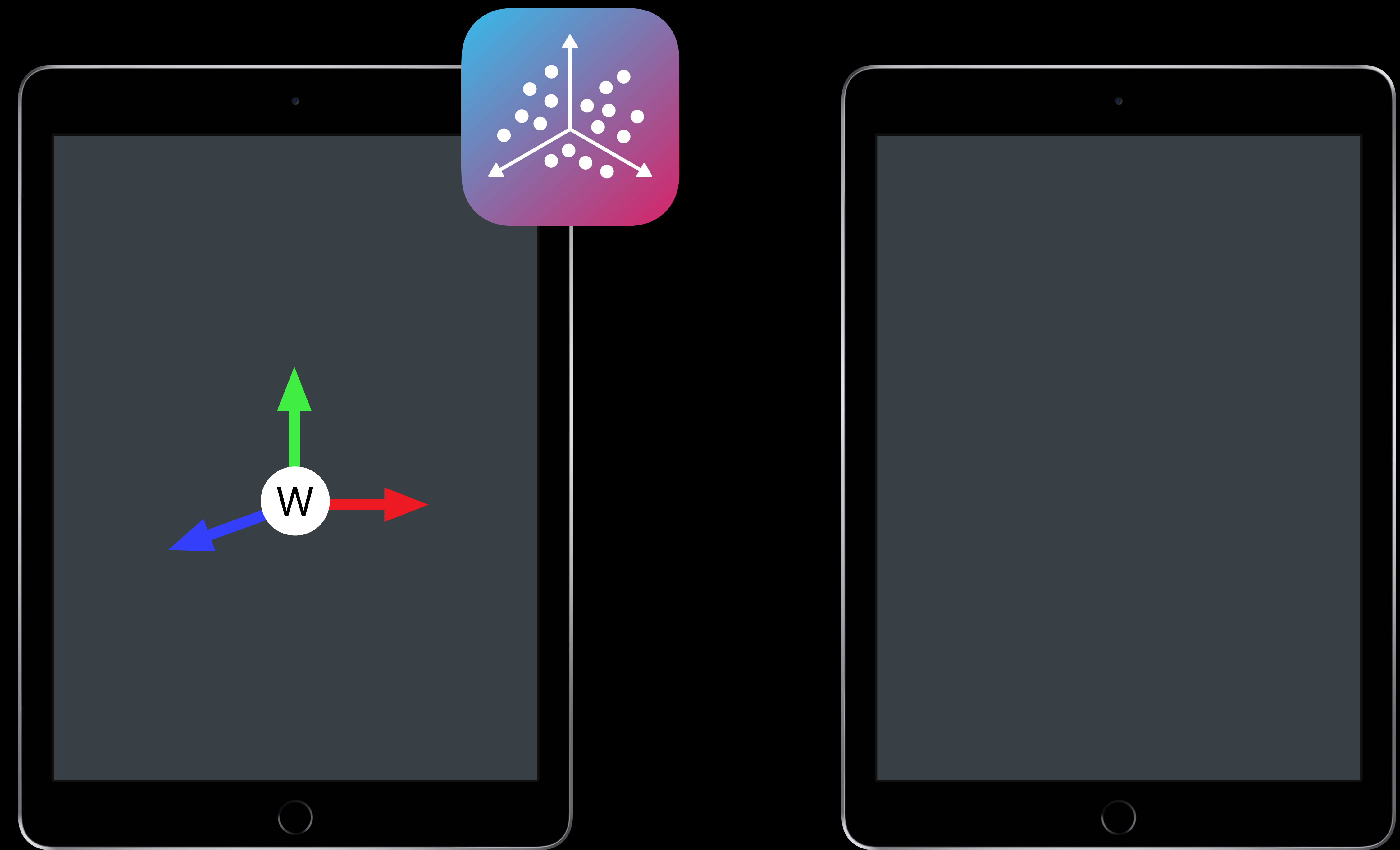


Saving and Loading World Map



Saving and Loading World Map

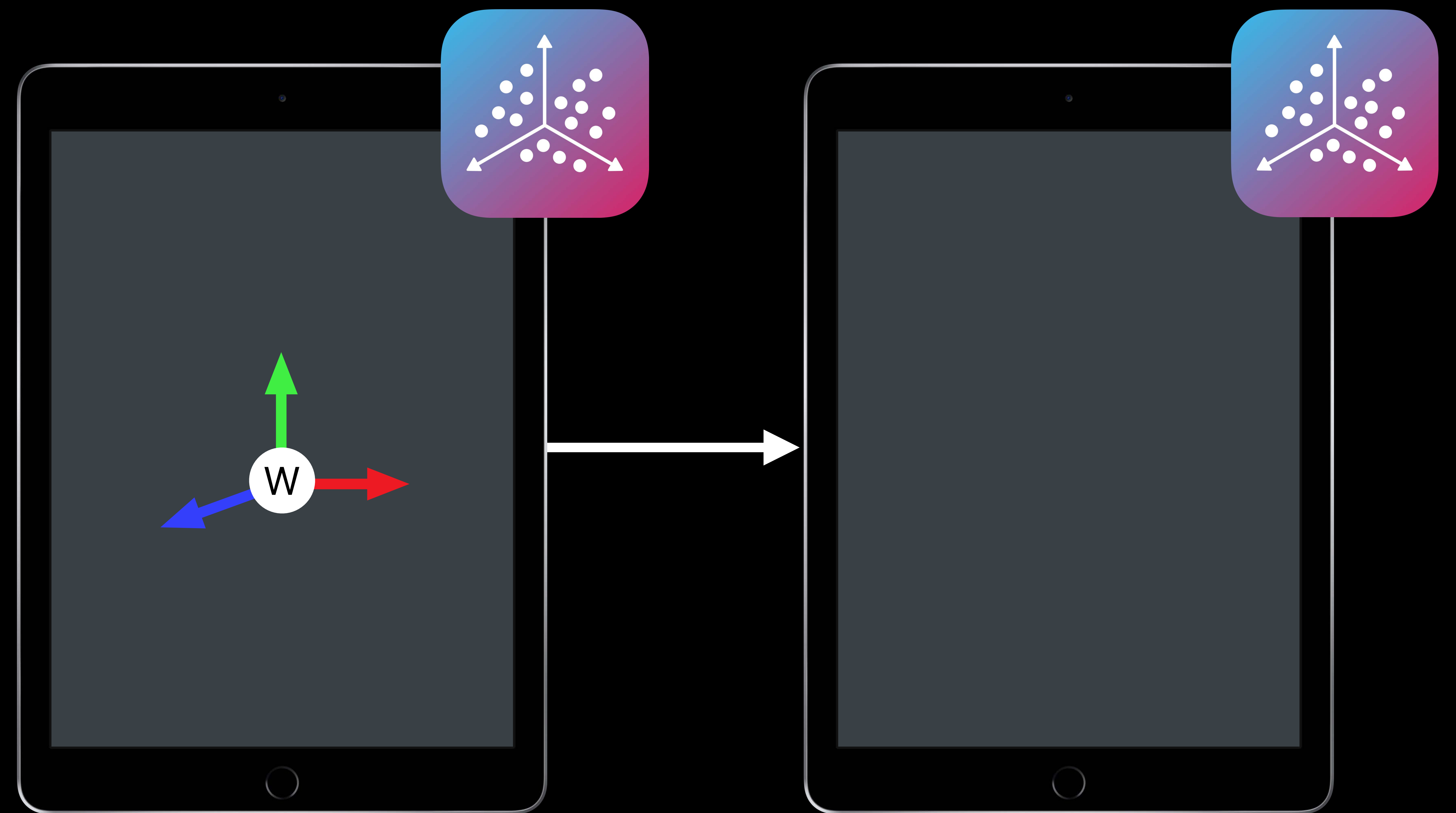
Acquire a good World Map



Saving and Loading World Map

Acquire a good World Map

Share the World Map

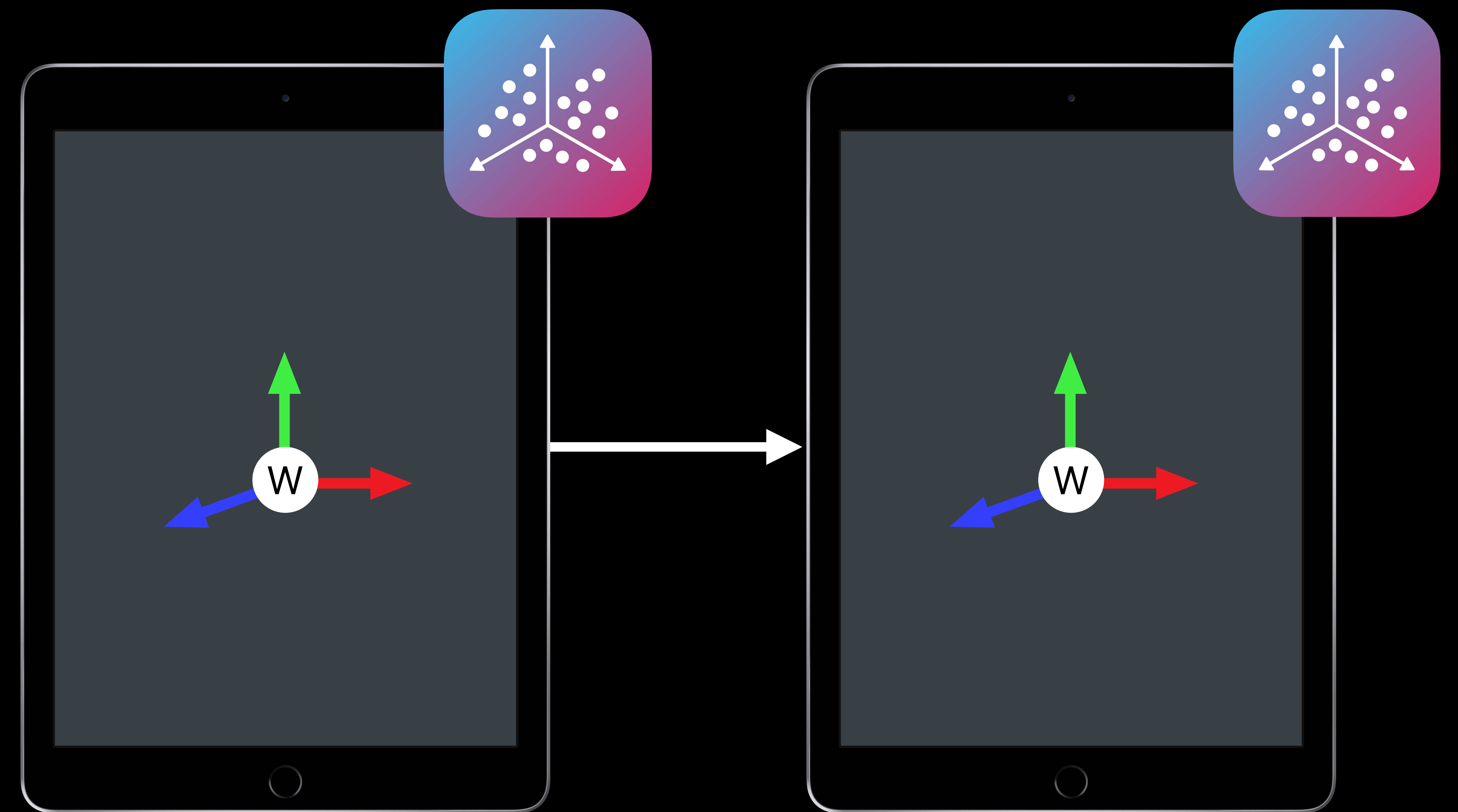


Saving and Loading World Map

Acquire a good World Map

Share the World Map

Relocalize to World Map



World Map Data

Internal tracking data

- Map of 3D feature points
- Local appearance

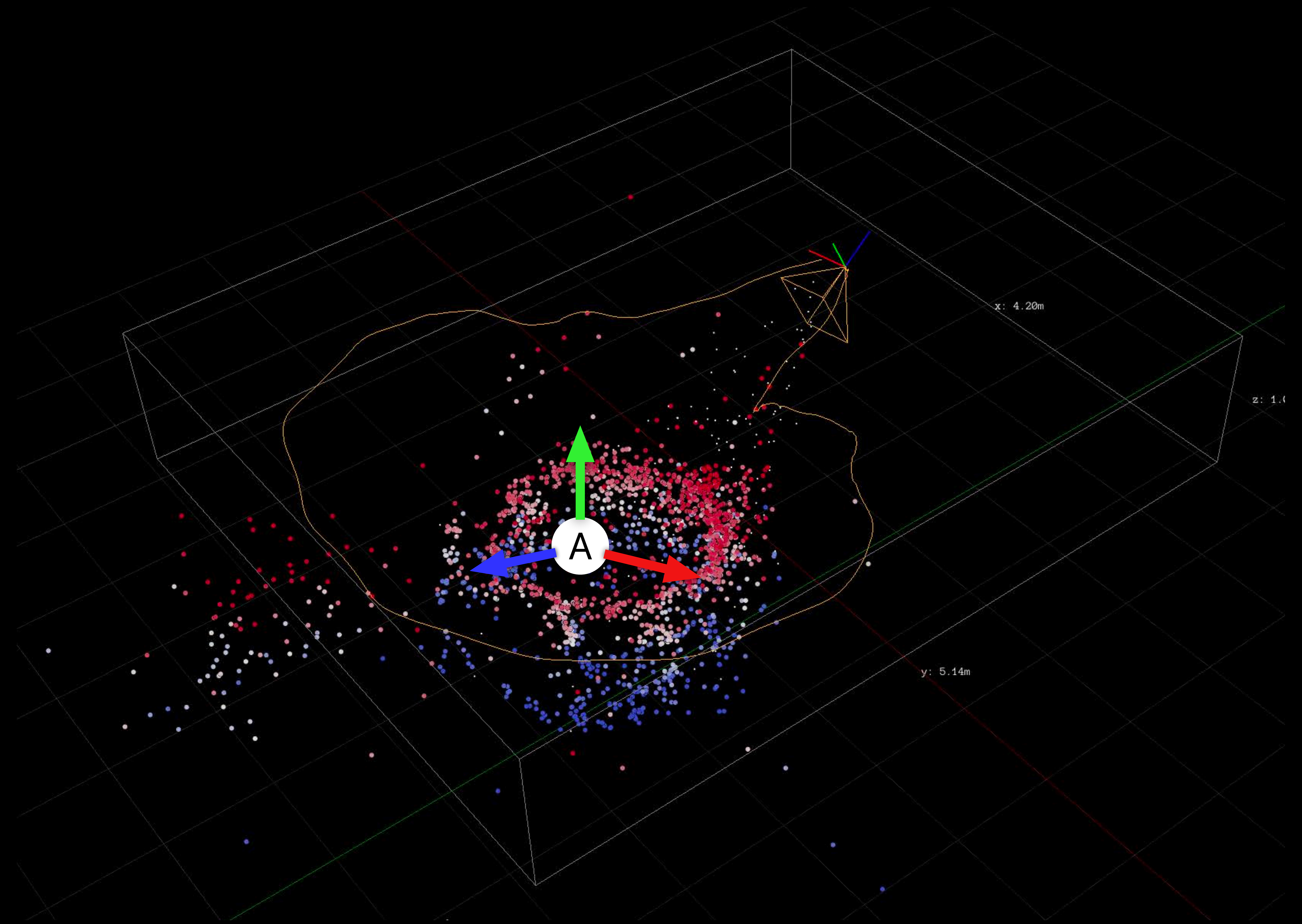


World Map Data

Internal tracking data

- Map of 3D feature points
- Local appearance

List of named anchors



World Map Data

Internal tracking data

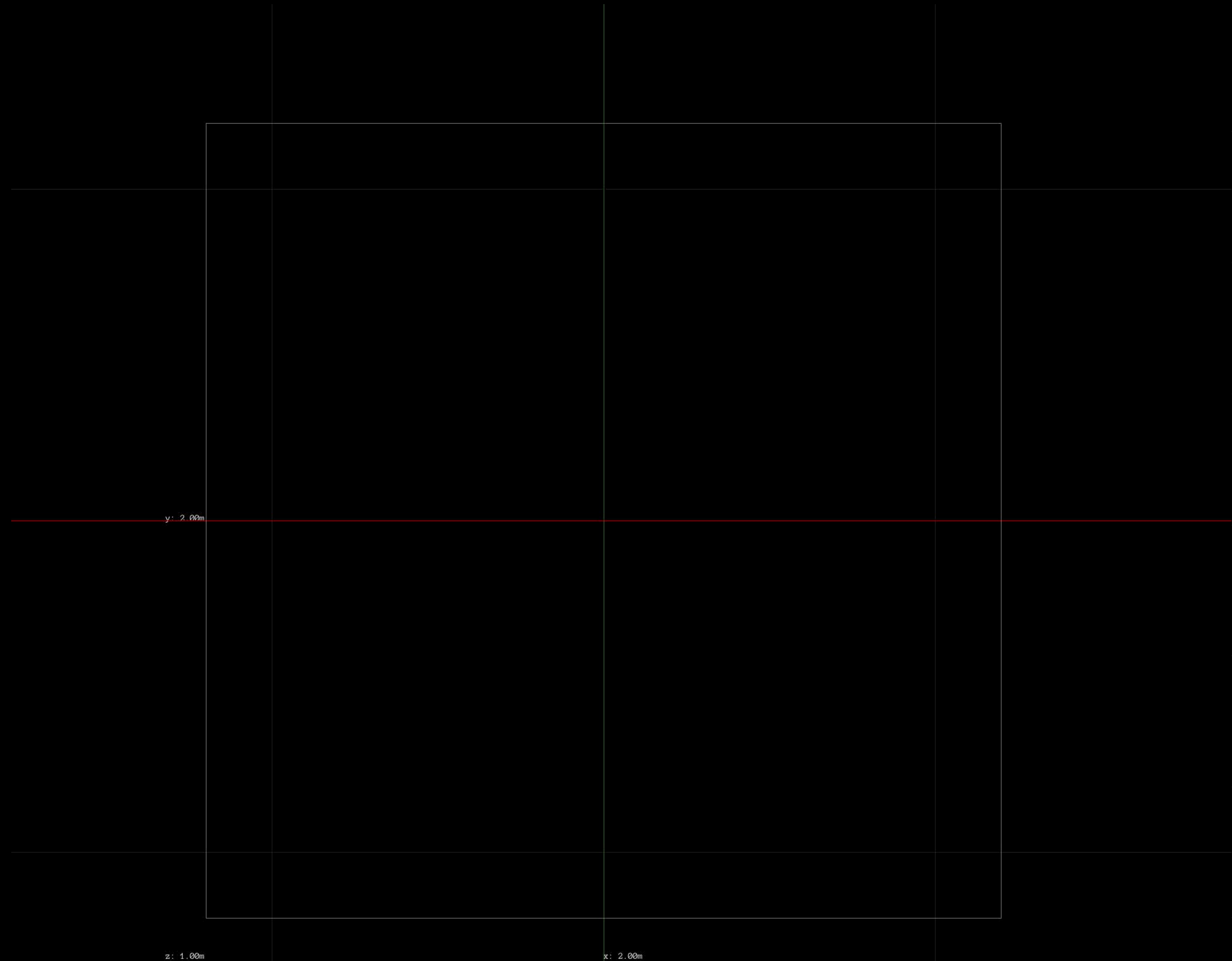
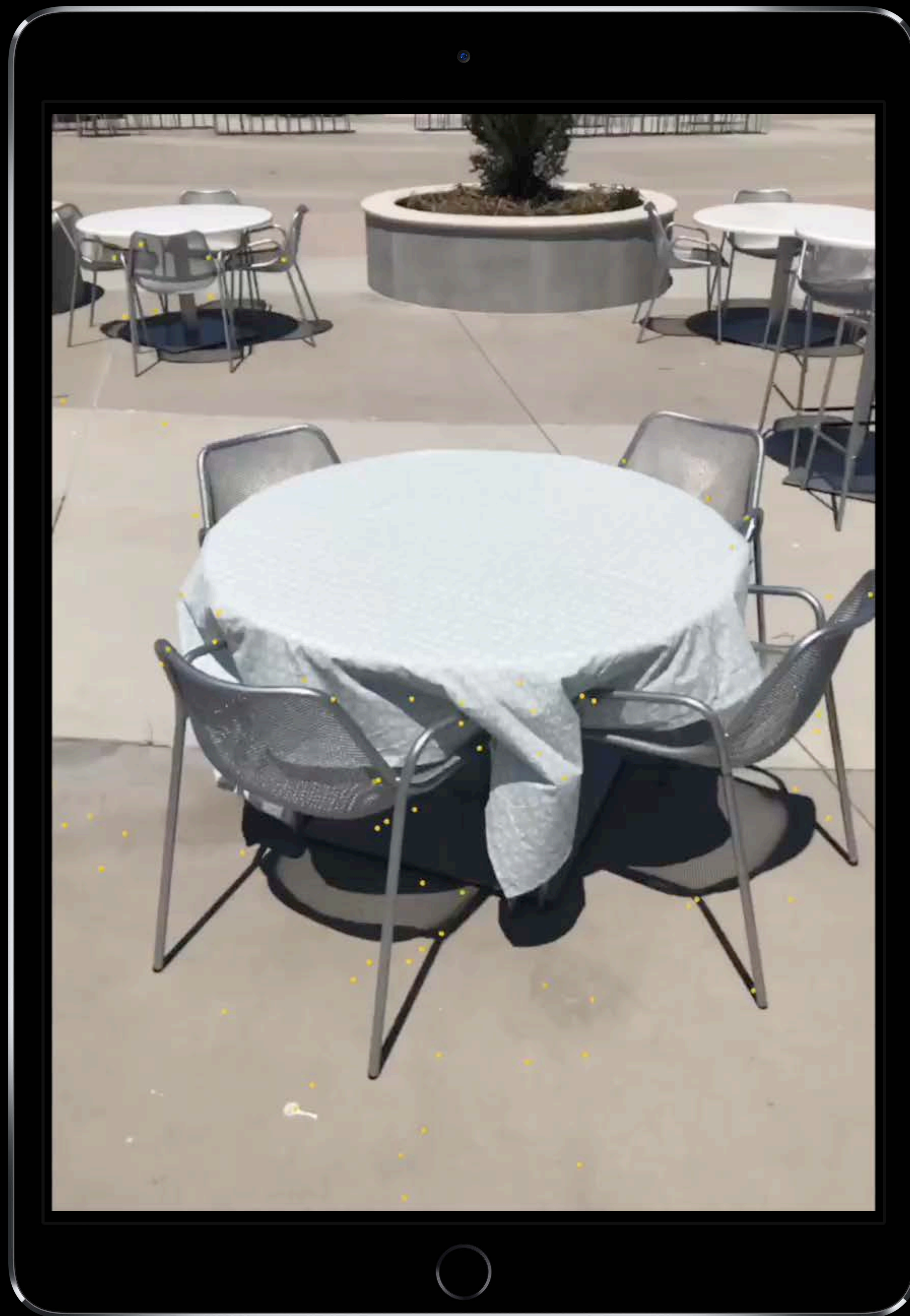
- Map of 3D feature points
- Local appearance

List of named anchors

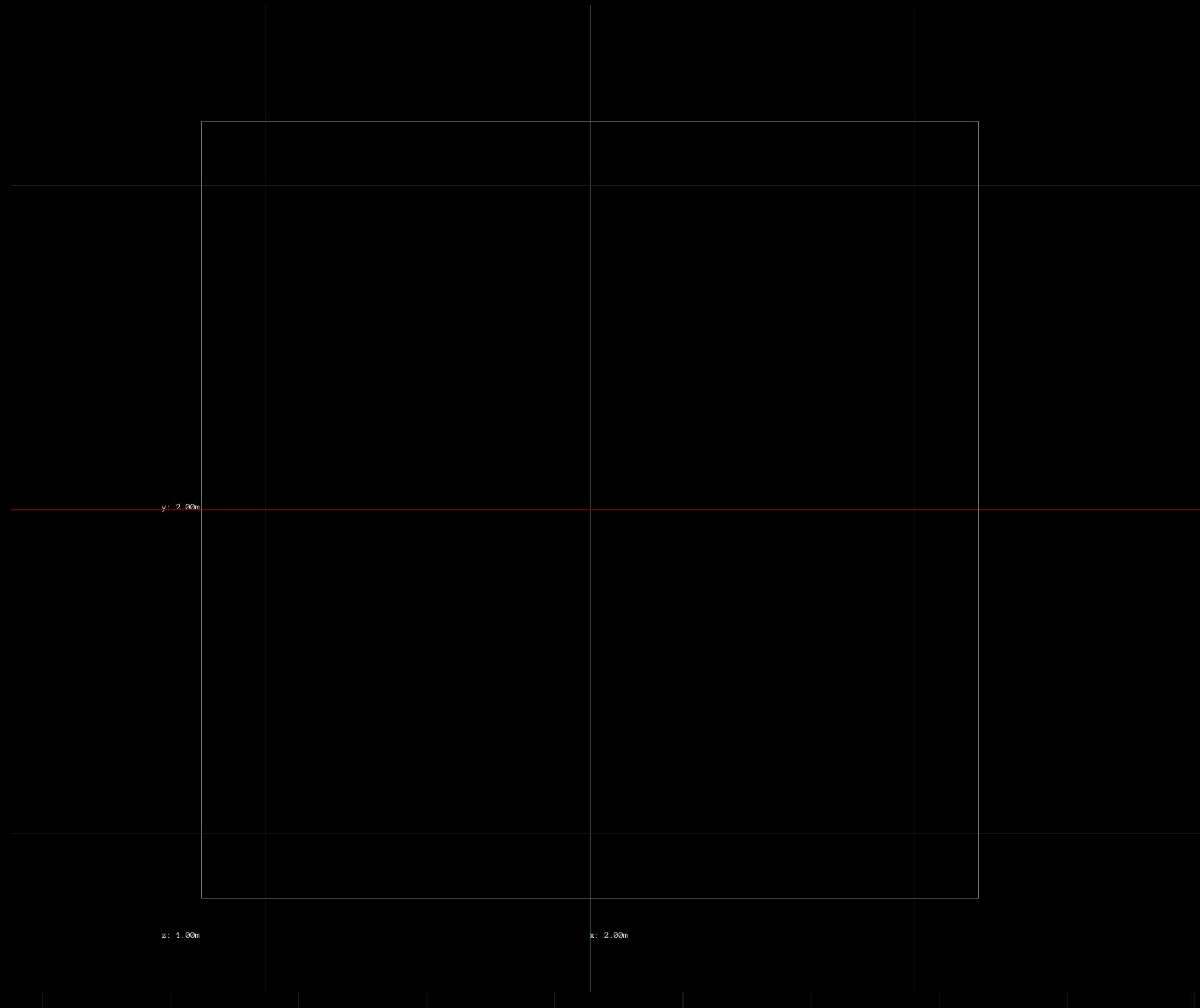
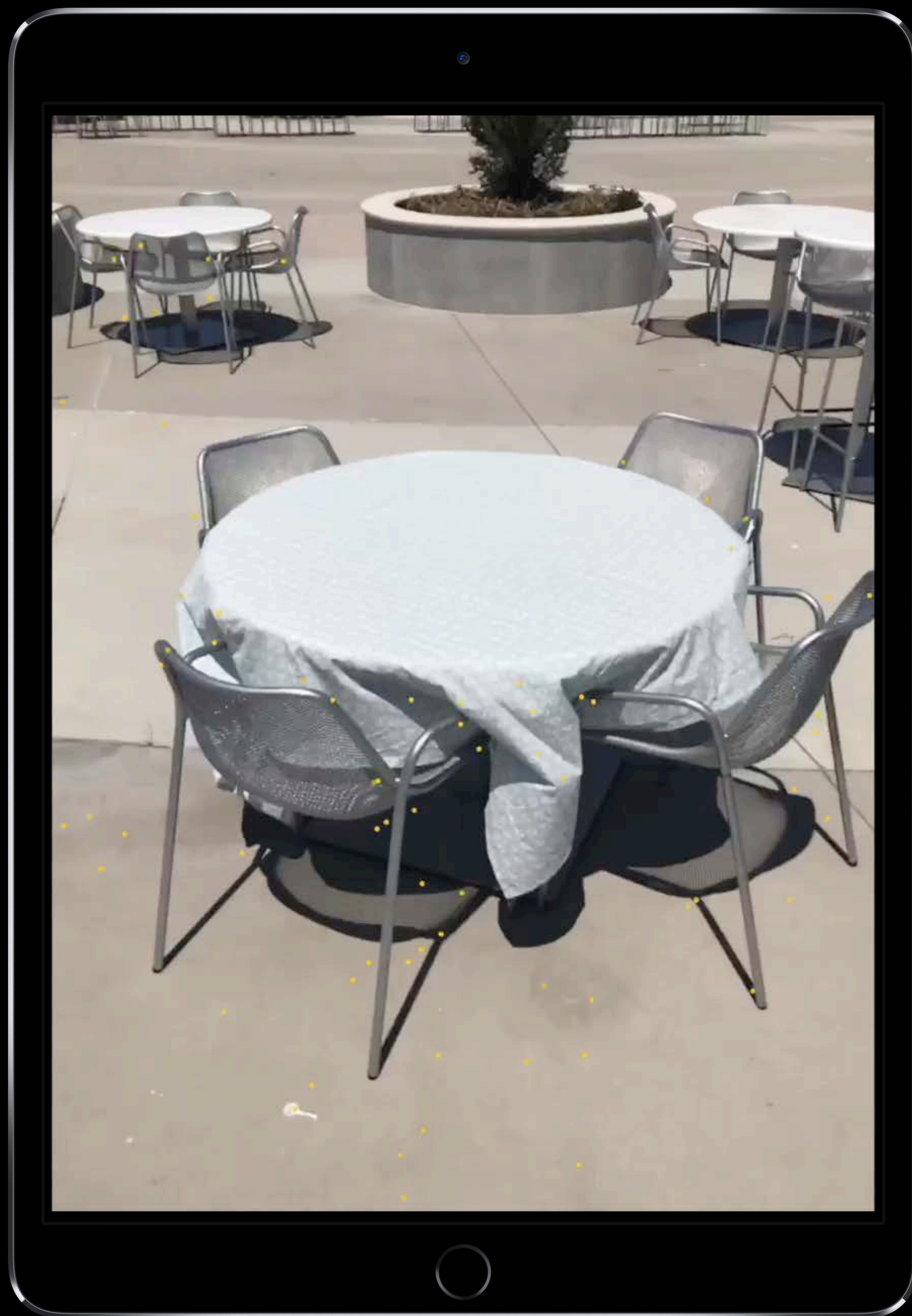
Serializable



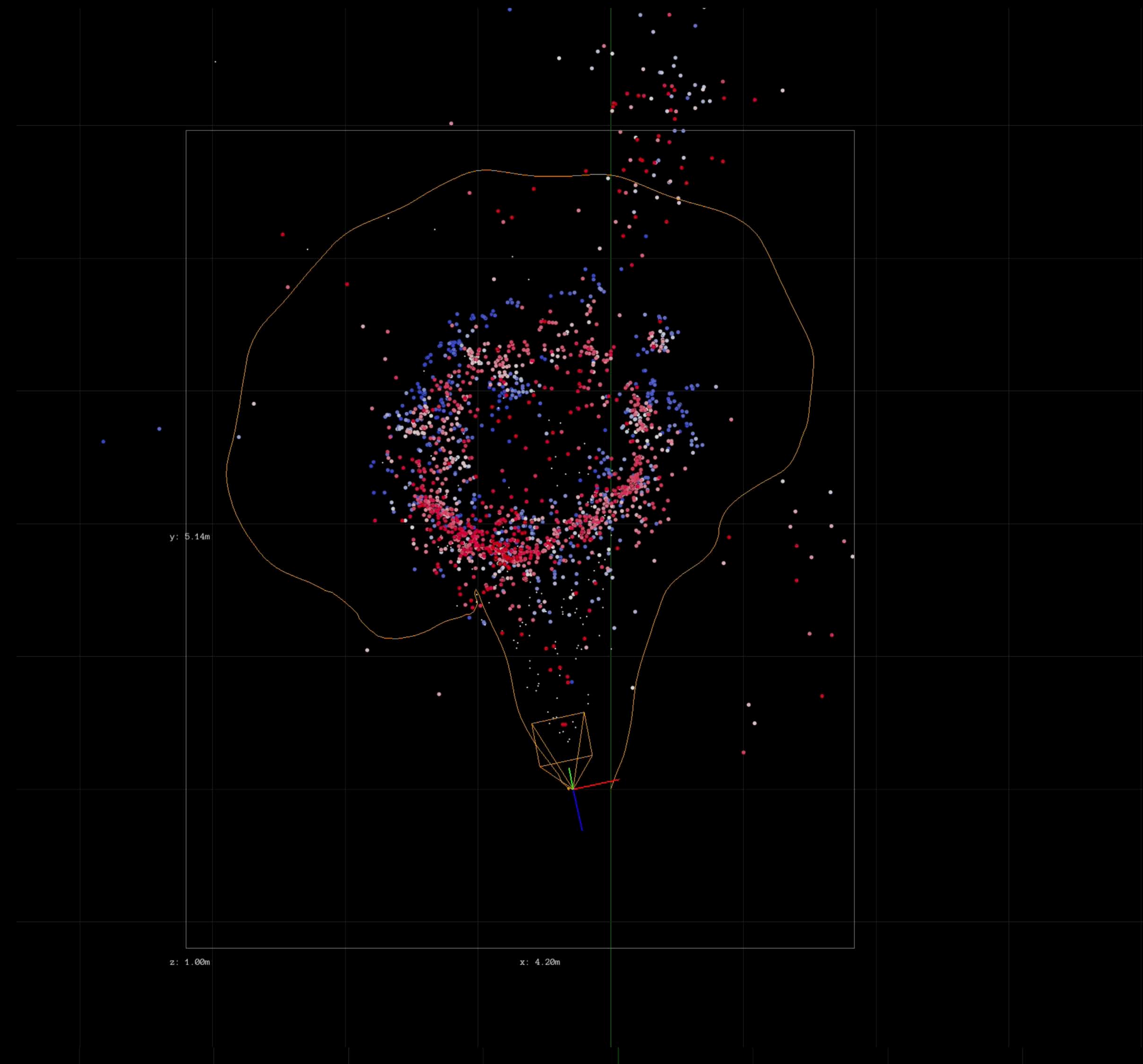
Acquiring a Good World Map



Acquiring a Good World Map

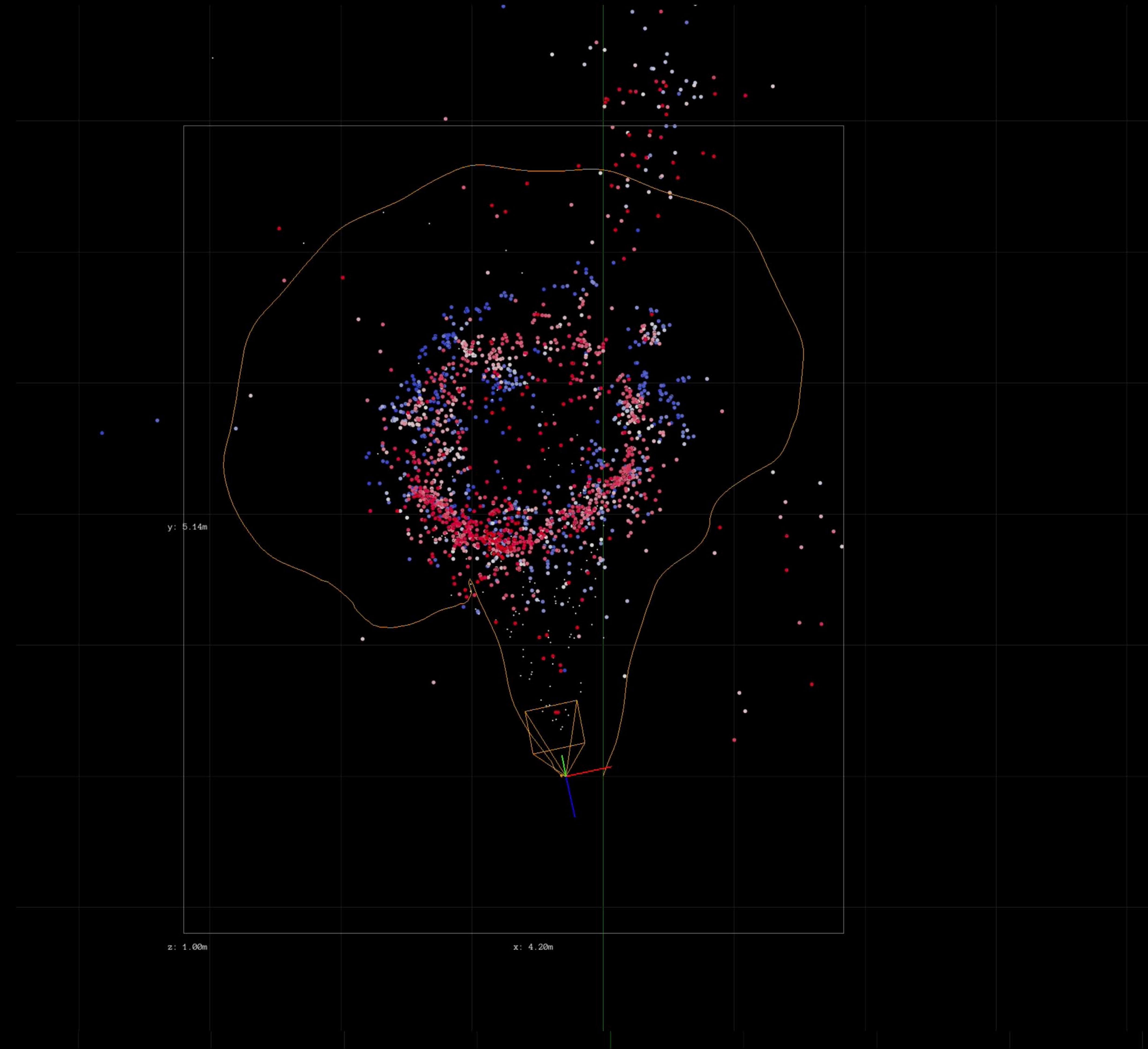


Acquiring a Good World Map



Acquiring a Good World Map

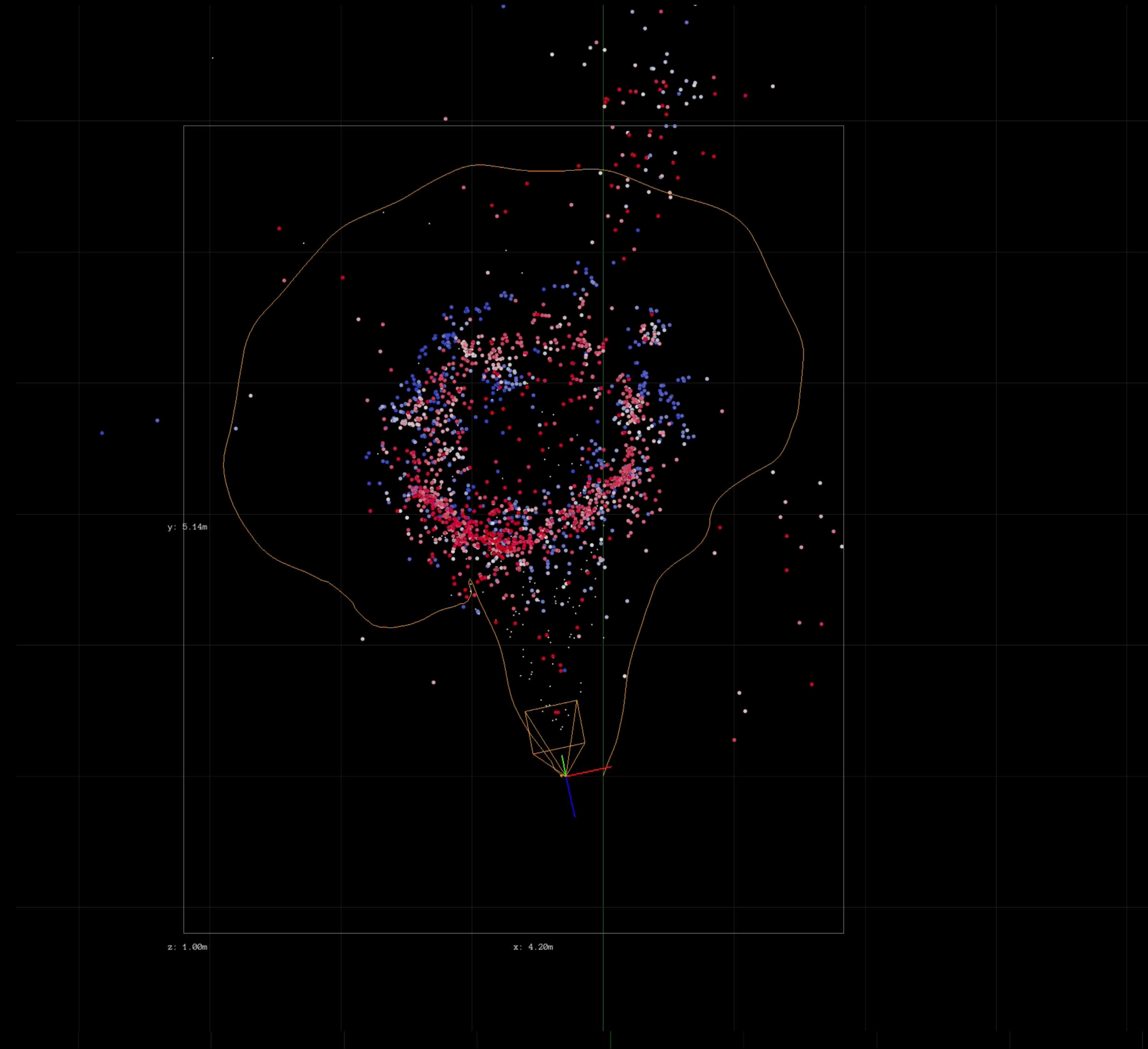
Dense feature points on map



Acquiring a Good World Map

Dense feature points on map

Static environment

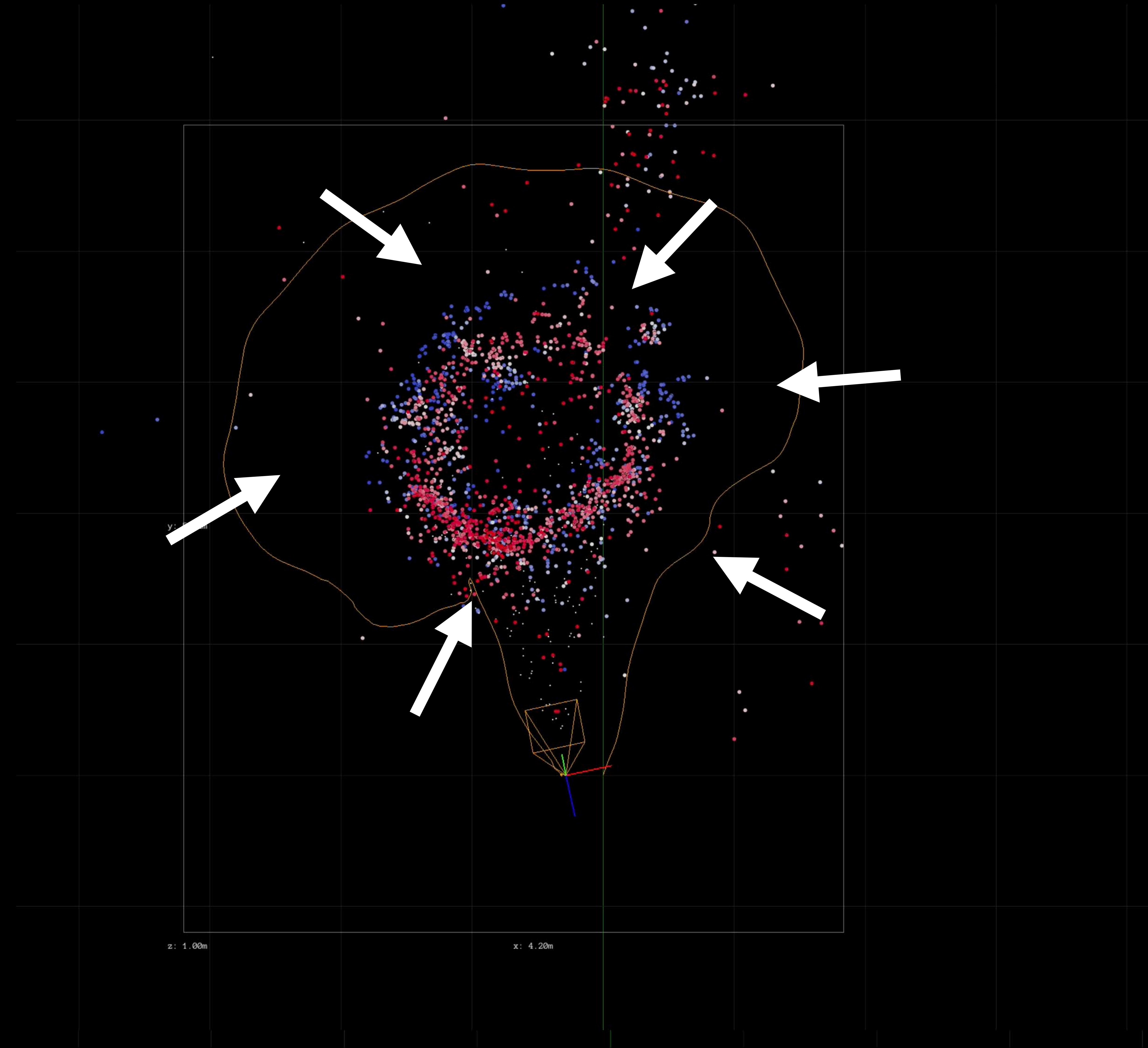


Acquiring a Good World Map

Dense feature points on map

Static environment

Multiple points of view



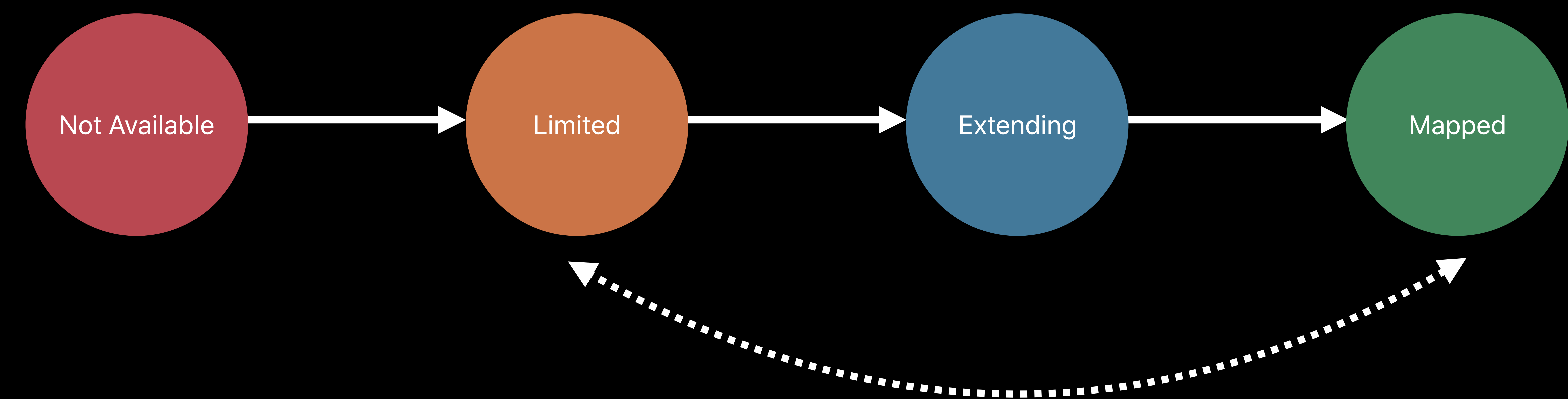
Acquiring a Good World Map

Dense feature points on map

Static environment

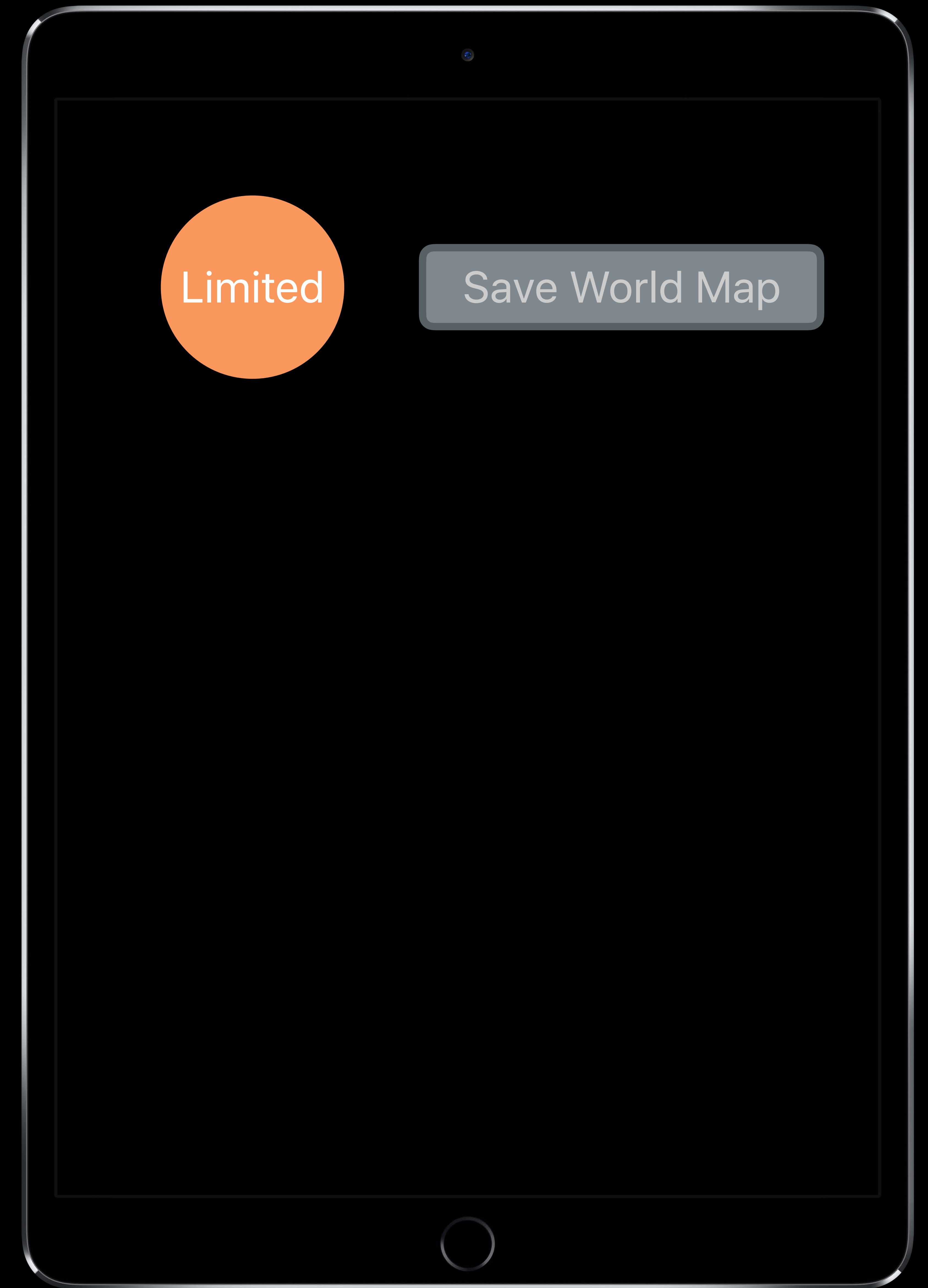
Multiple points of view

World mapping status



Acquiring a Good World Map

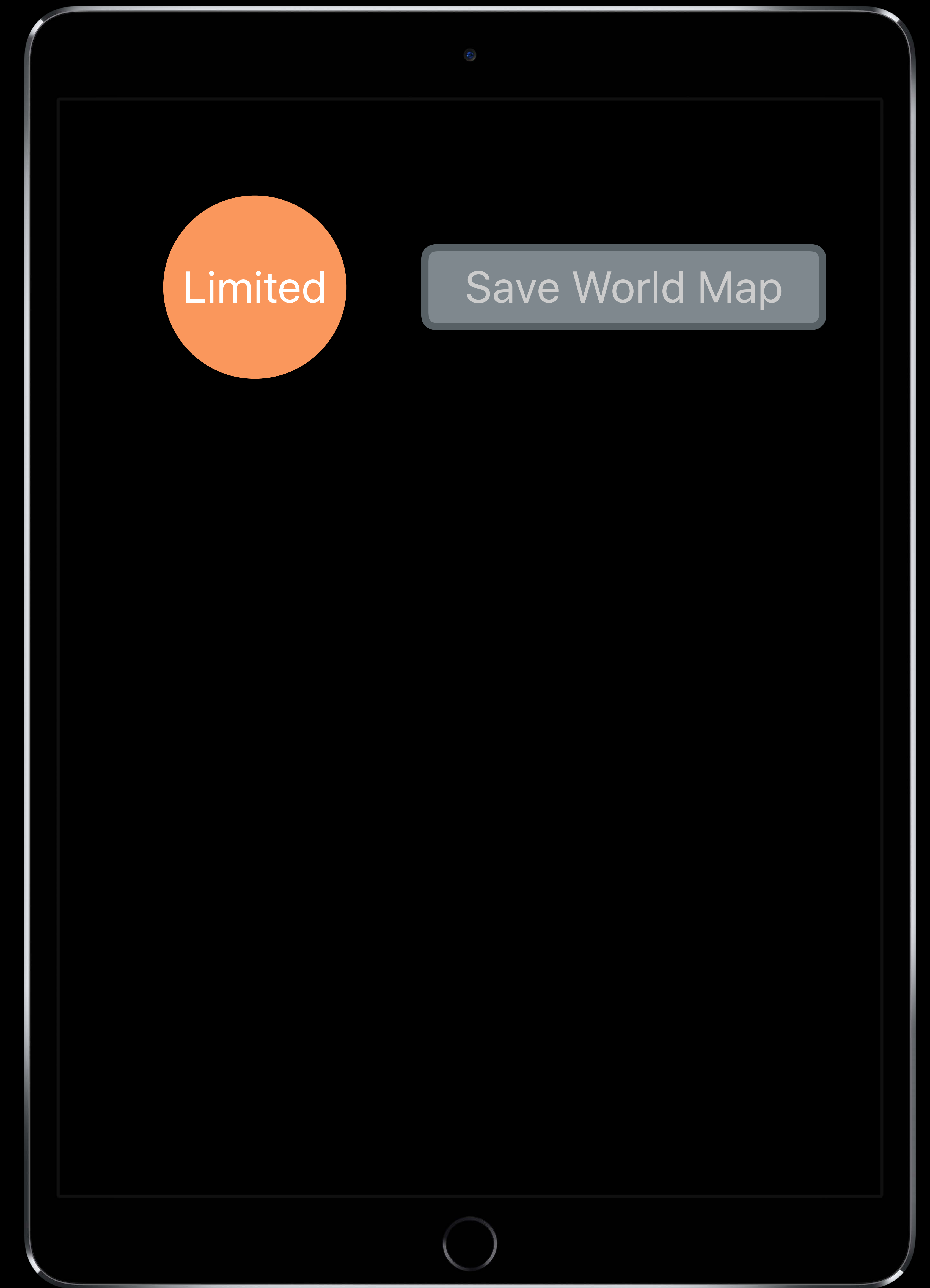
Guide the user



Acquiring a Good World Map

Guide the user

Indicate mapping status



Acquiring a Good World Map

Guide the user

Indicate mapping status

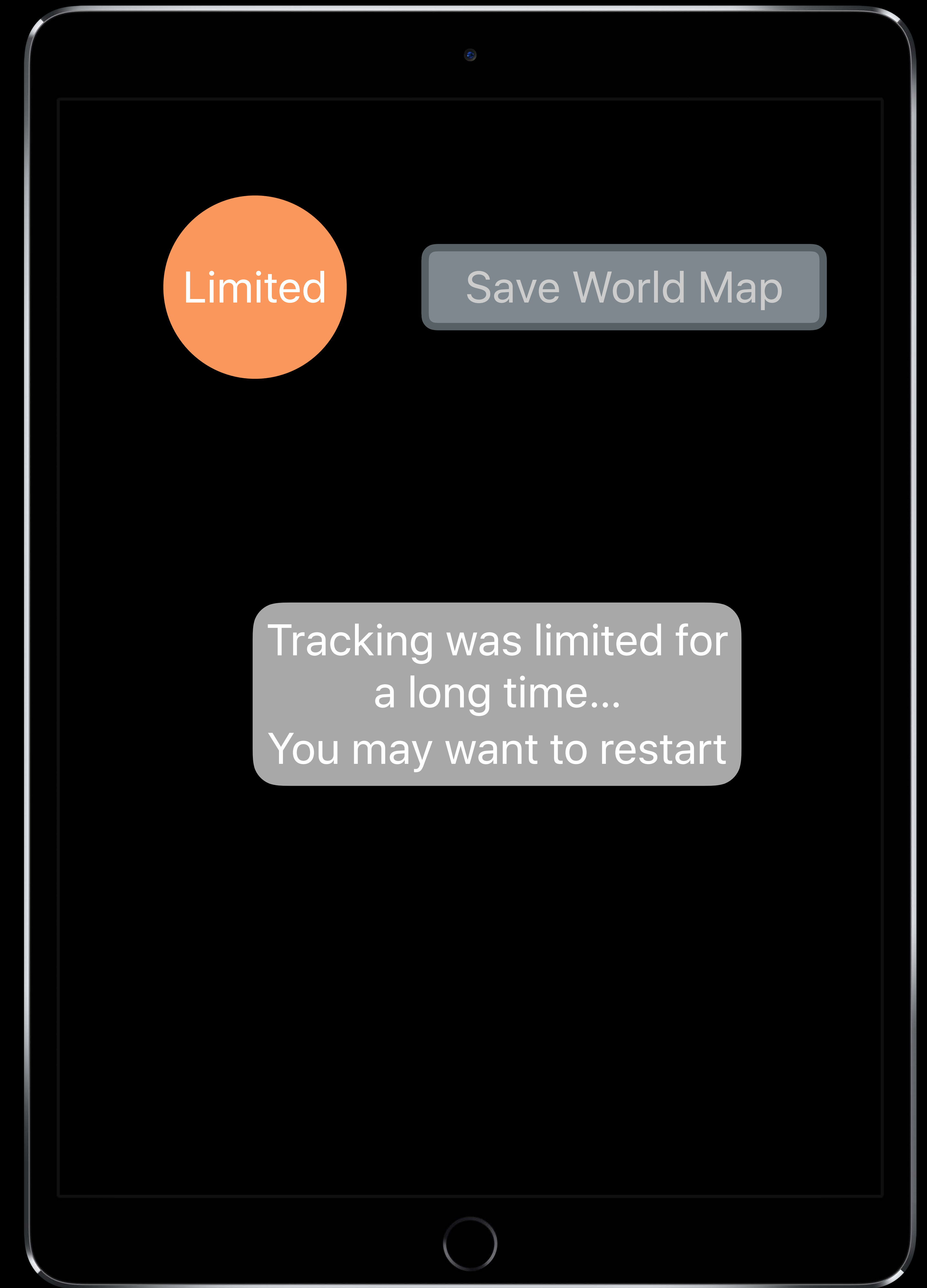


Acquiring a Good World Map

Guide the user

Indicate mapping status

Warn about limited tracking state



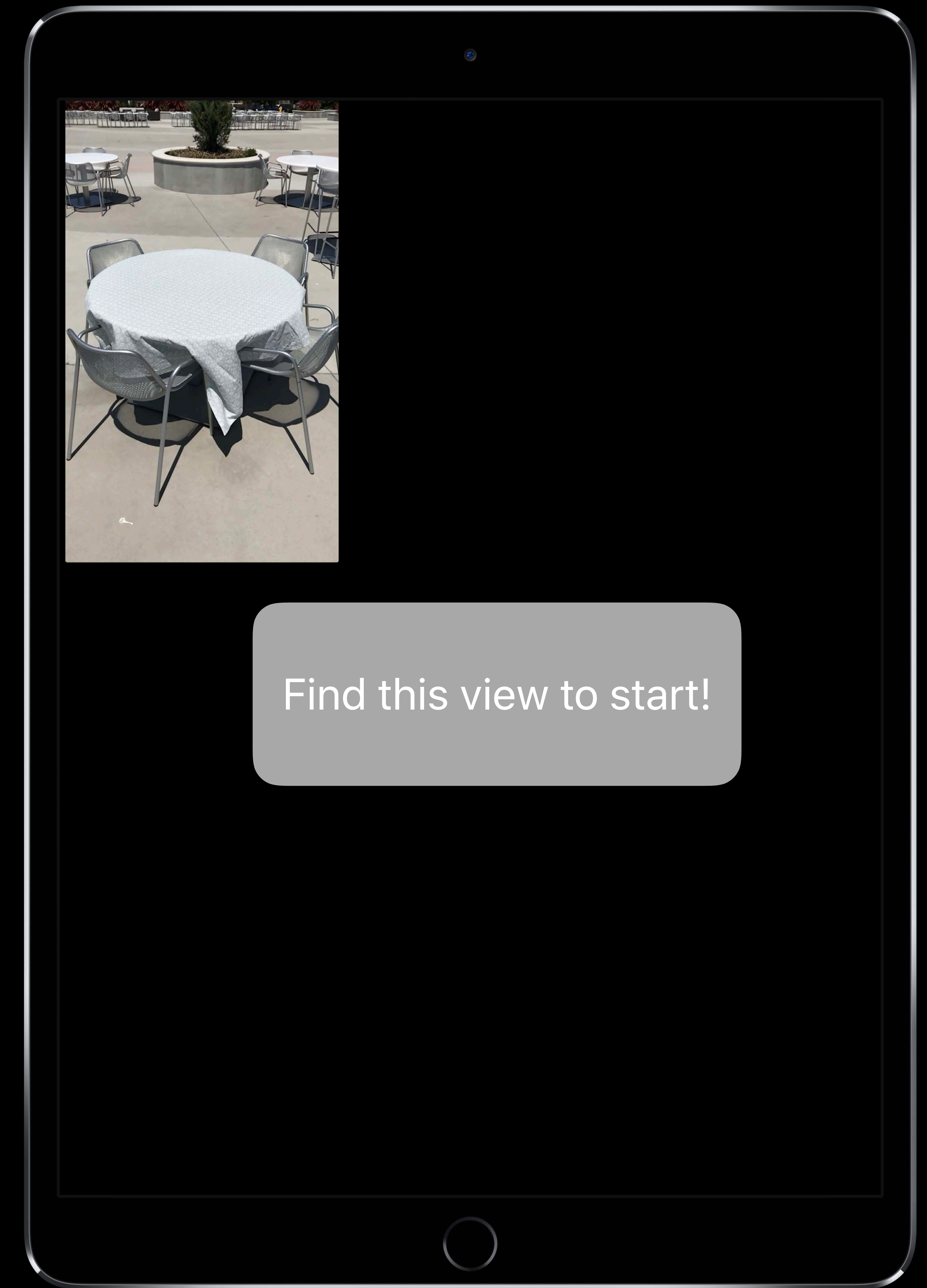
Acquiring a Good World Map

Guide the user

Indicate mapping status

Warn about limited tracking state

Guide relocalization



Share the World Map

```
// Retrieve world map from ARSession
session.getCurrentWorldMap { worldMap, error in
    guard let worldMap = worldMap else {
        showAlert(error)
        return
    }
    // Serialize
    let data = try NSKeyedArchiver.archivedData(withRootObject: worldMap,
                                                requiringSecureCoding: true)
}
```

For shared experiences—MultipeerConnectivity framework
See sample “Creating a Multiuser AR Experience”

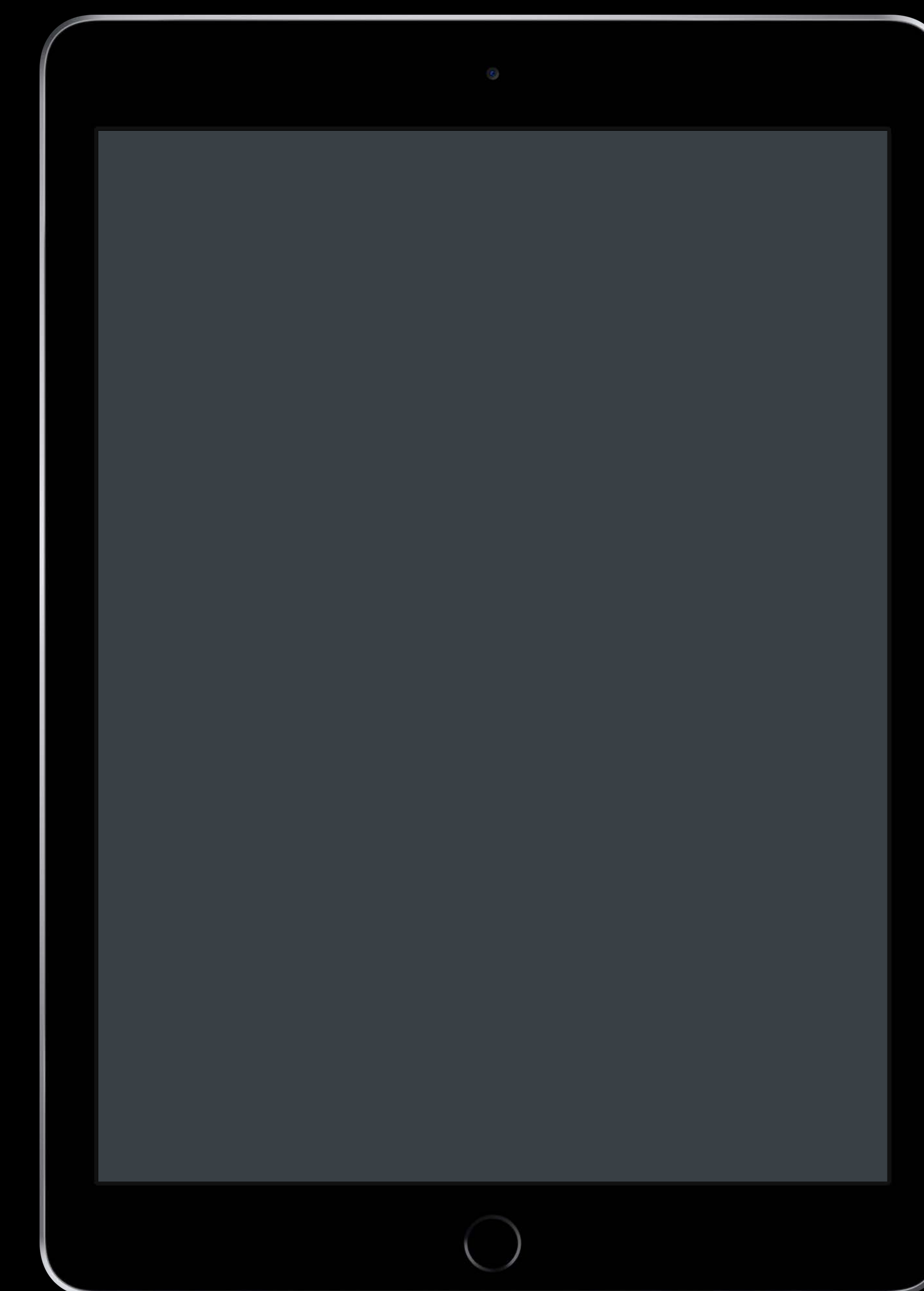
Relocalize to World Map

Setup configuration

```
// Receive / Load world map
let worldMap : ARWorldMap = ...

// Create a session configuration
let configuration = ARWorldTrackingConfiguration()
configuration.initialWorldMap = worldMap

// Run the session
session.run(configuration)
```



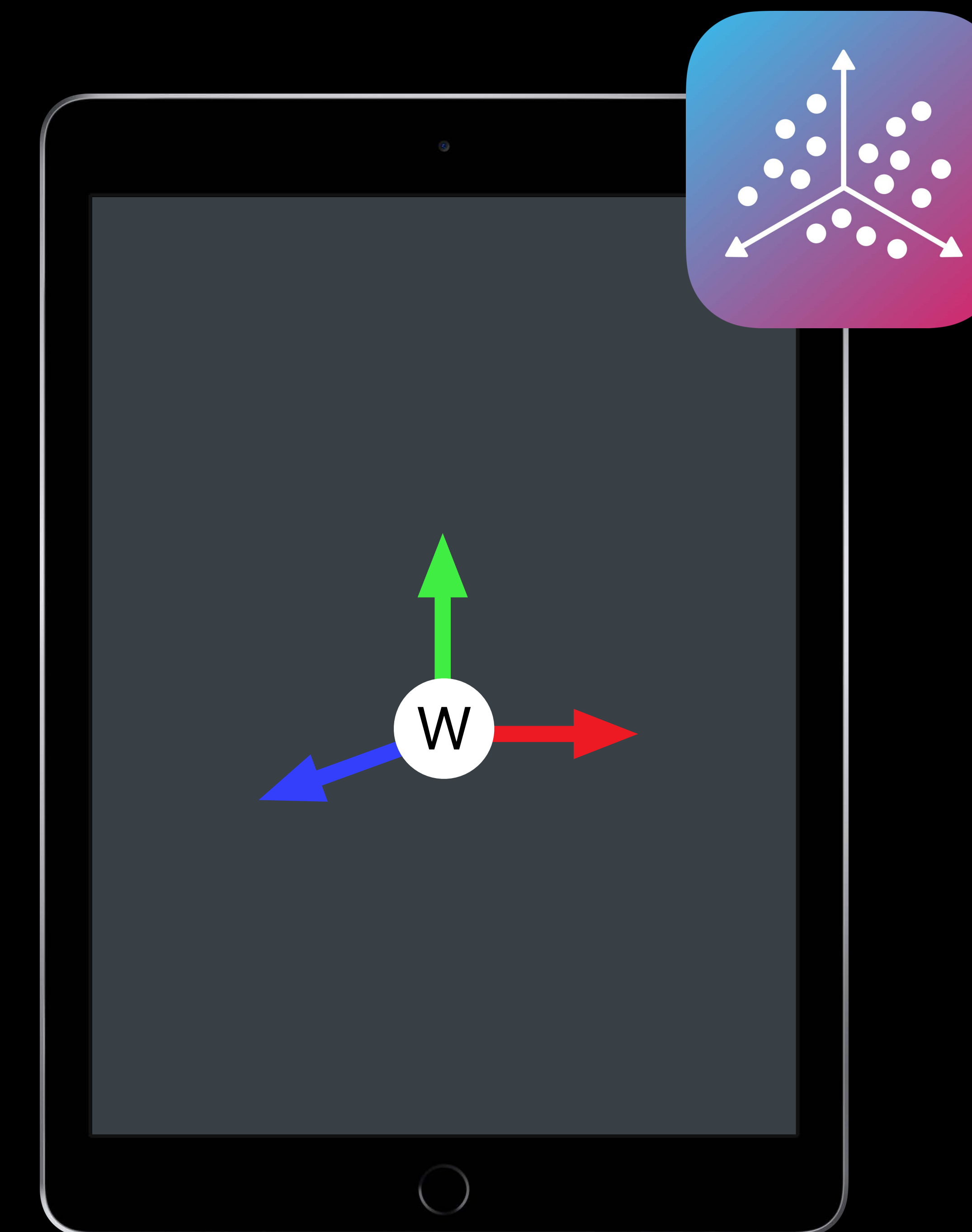
Relocalize to World Map

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// Create a session configuration
let configuration = ARWorldTrackingConfiguration()
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session.run(configuration)
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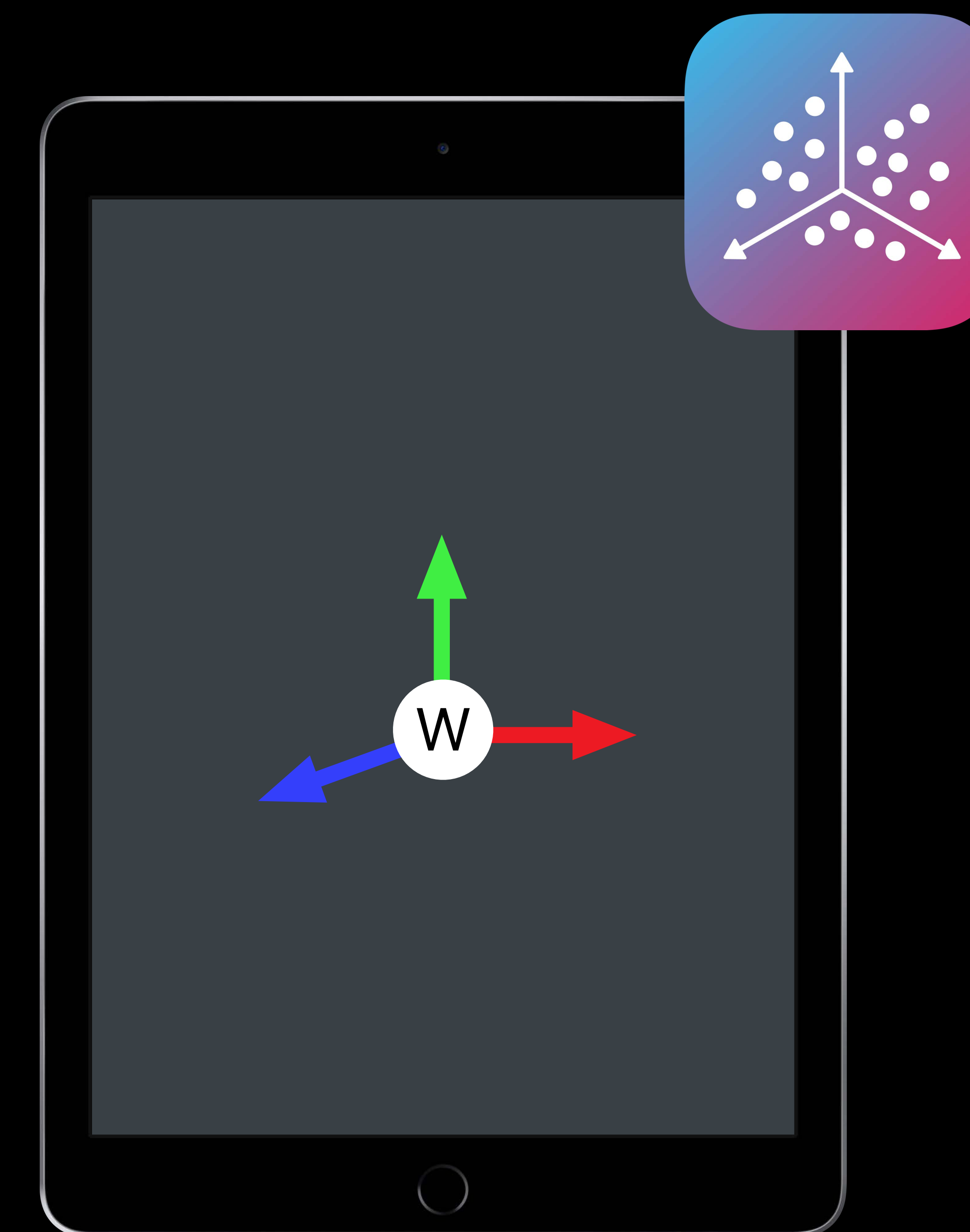
Relocalize to World Map

Setup configuration

```
// Receive / Load world map
let worldMap : ARWorldMap = ...

// Create a session configuration
let configuration = ARWorldTrackingConfiguration()
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// Run the session
session.run(configuration)
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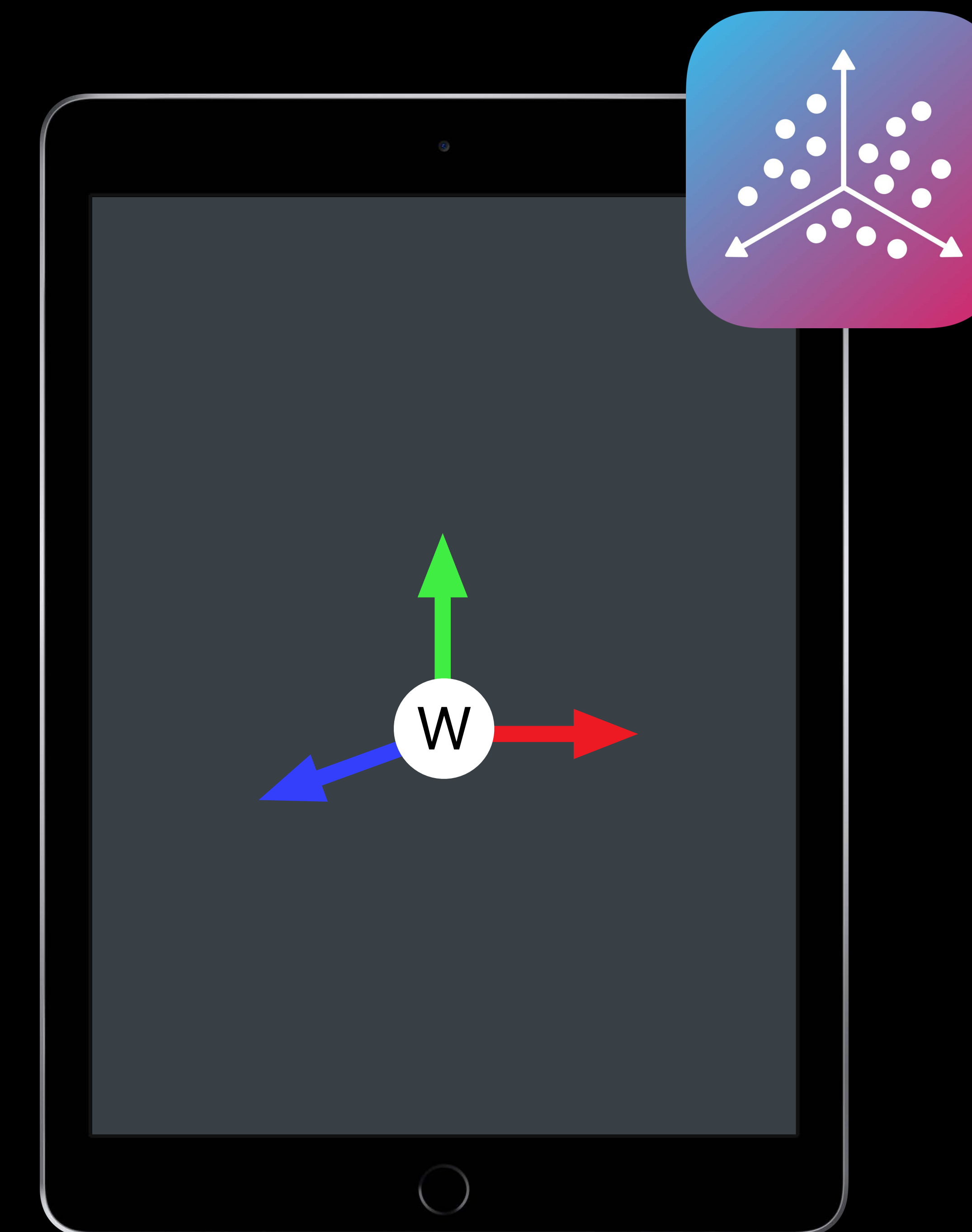
Relocalize to World Map

Setup configuration

```
// Receive / Load world map
let worldMap : ARWorldMap = ...

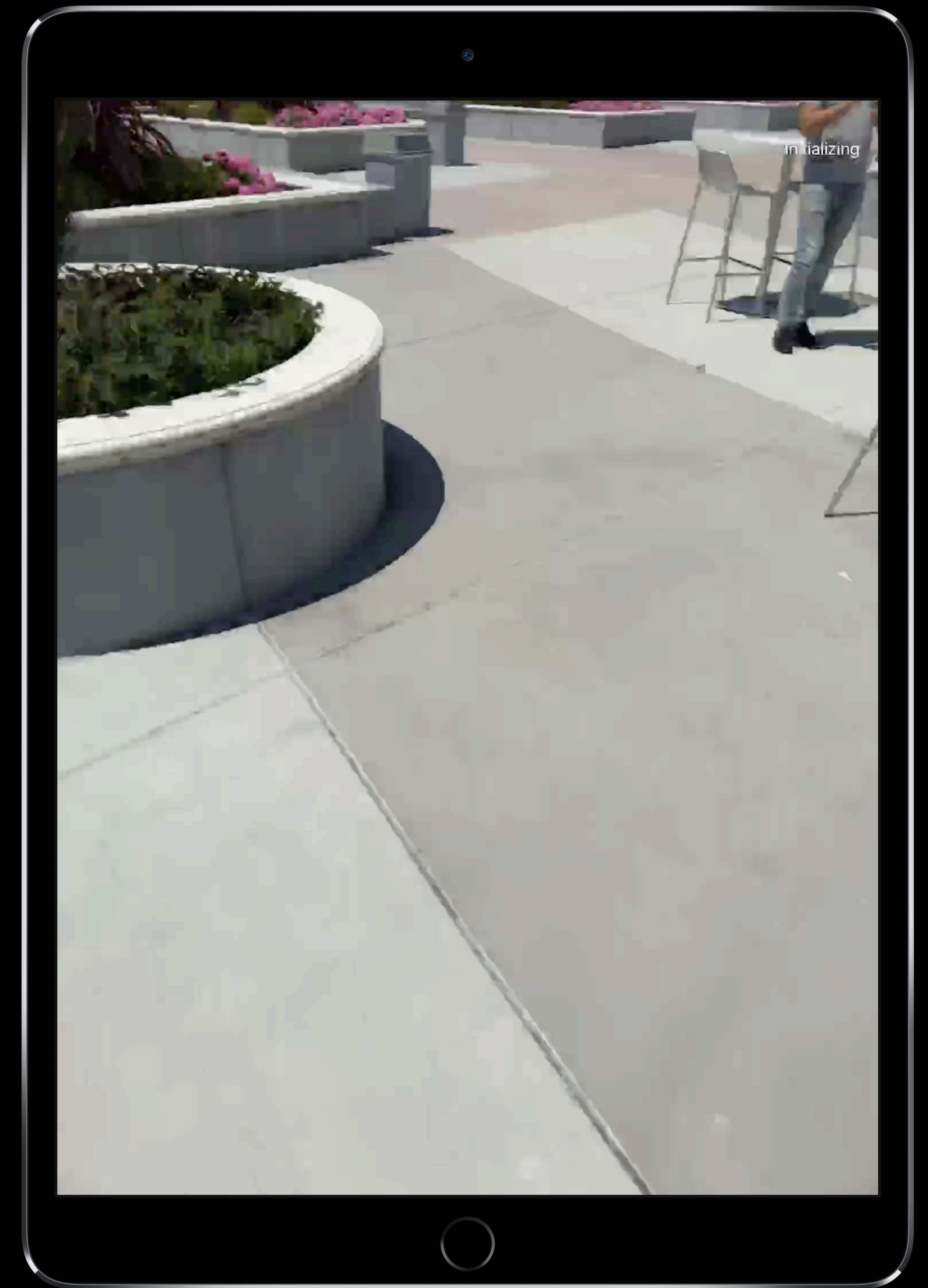
// Create a session configuration
let configuration = ARWorldTrackingConfiguration()
configuration.initialWorldMap = worldMap

// Run the session
session.run(configuration)
```



Relocalize to World Map

Before Relocalization



Relocalize to World Map

Before Relocalization

Tracking state is **Limited**
with reason **Relocalizing**

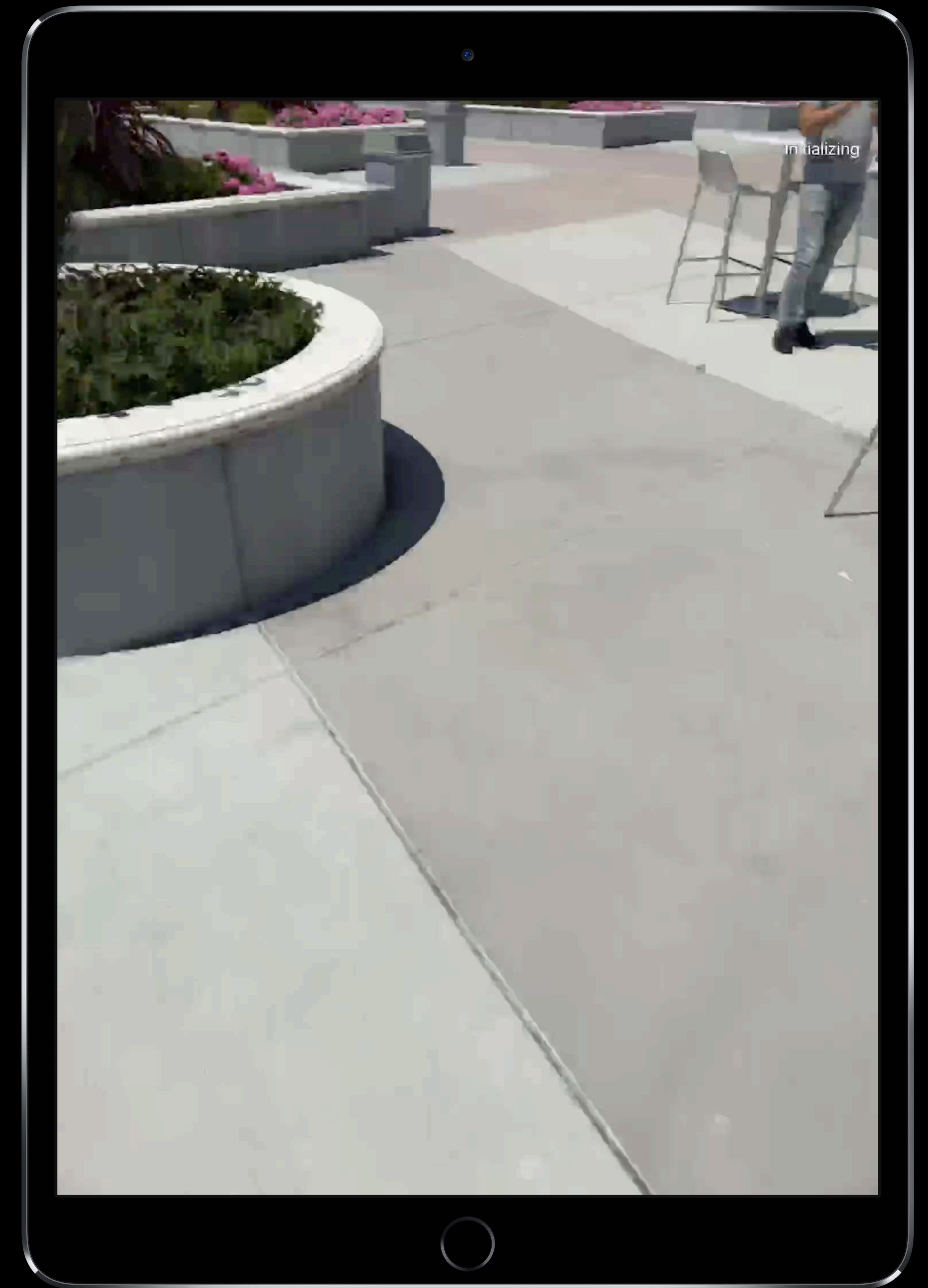


Relocalize to World Map

Before Relocalization

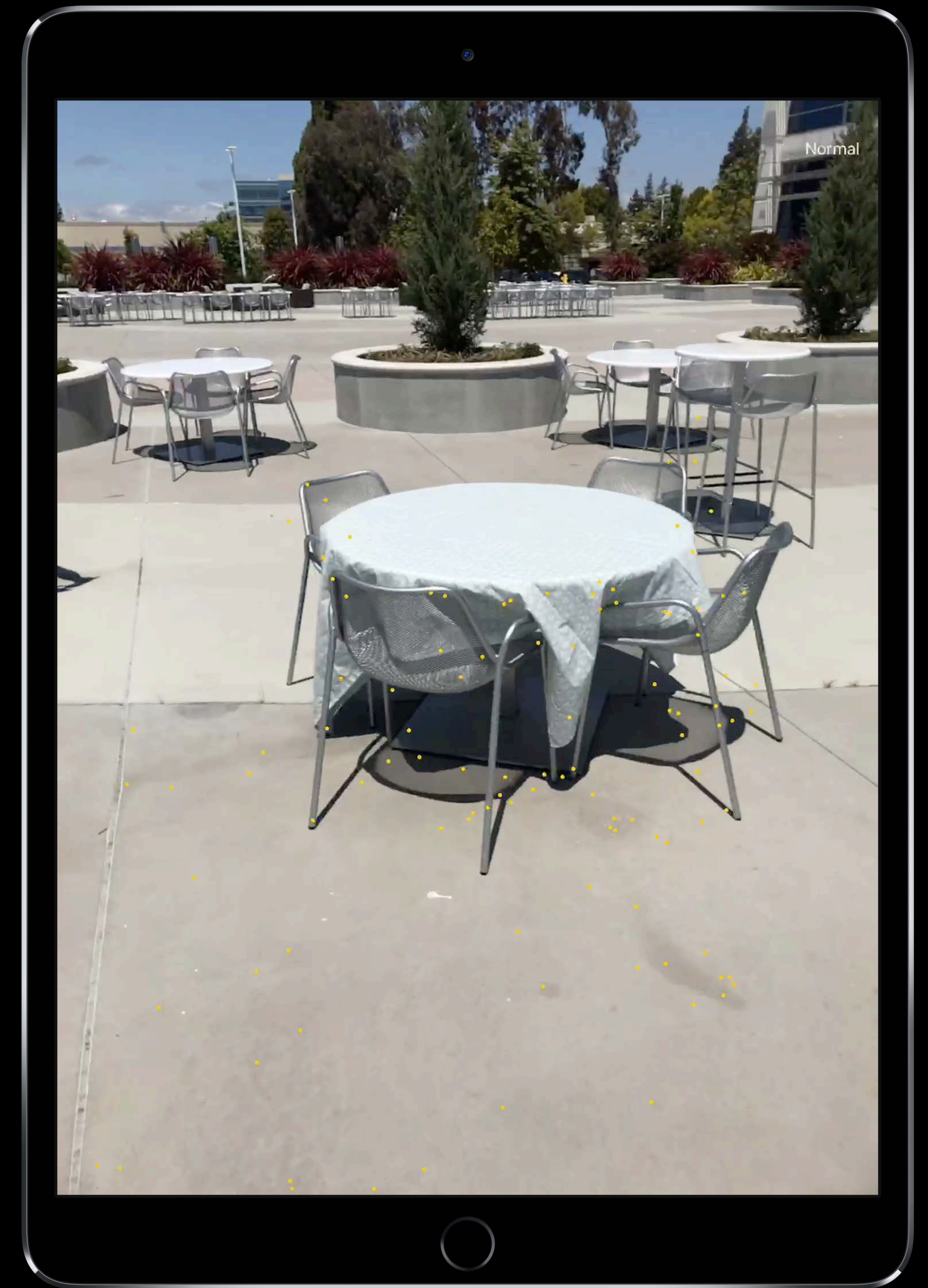
Tracking state is **Limited**
with reason **Relocalizing**

World origin is first camera



Relocalize to World Map

After Relocalization

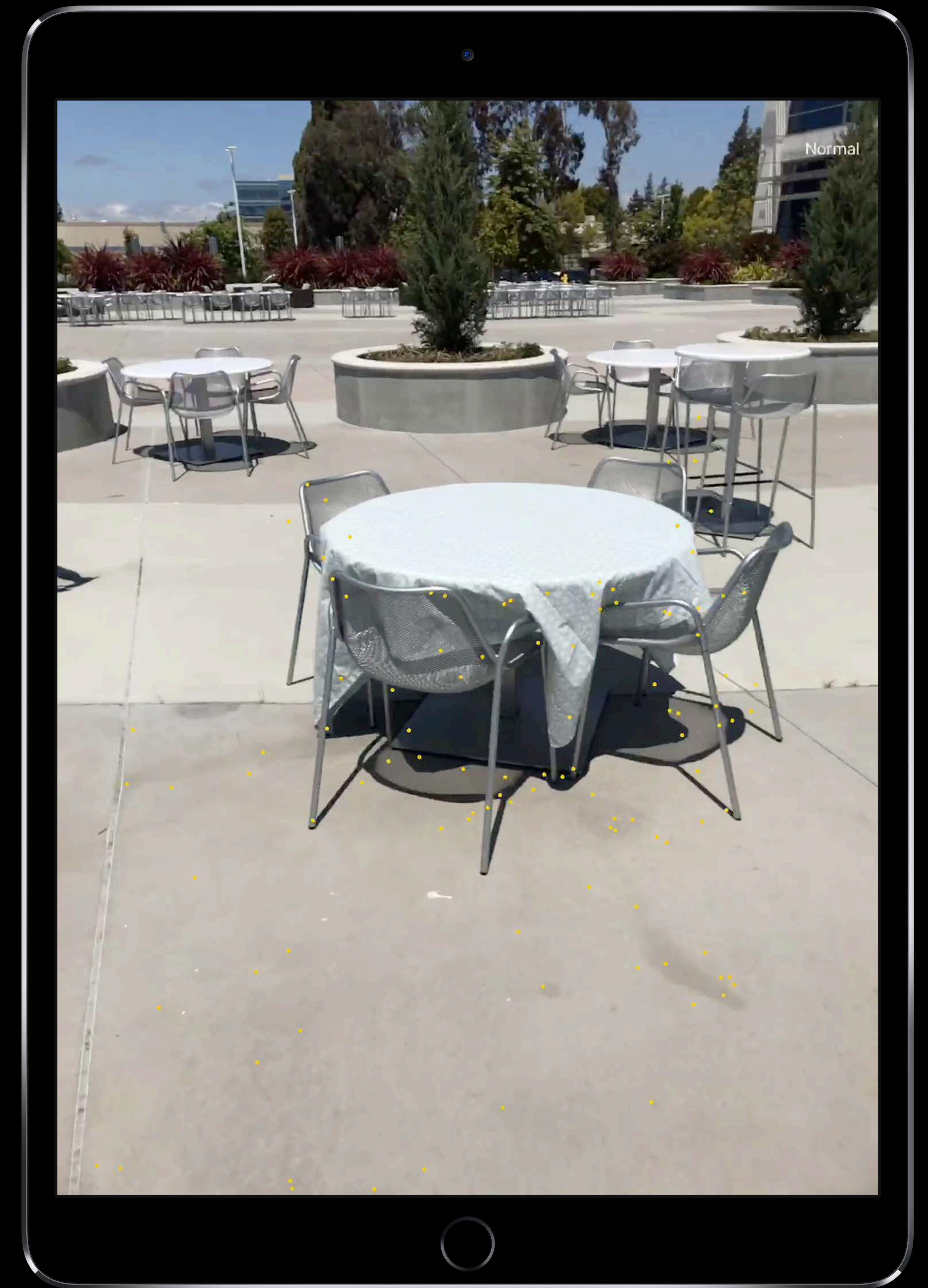


Relocalize to World Map

After Relocalization

Tracking state is **Normal**

World origin is initial world map



Relocalize to World Map

After Relocalization

Tracking state is **Normal**

World origin is initial world map

Only minor changes in environment allowed

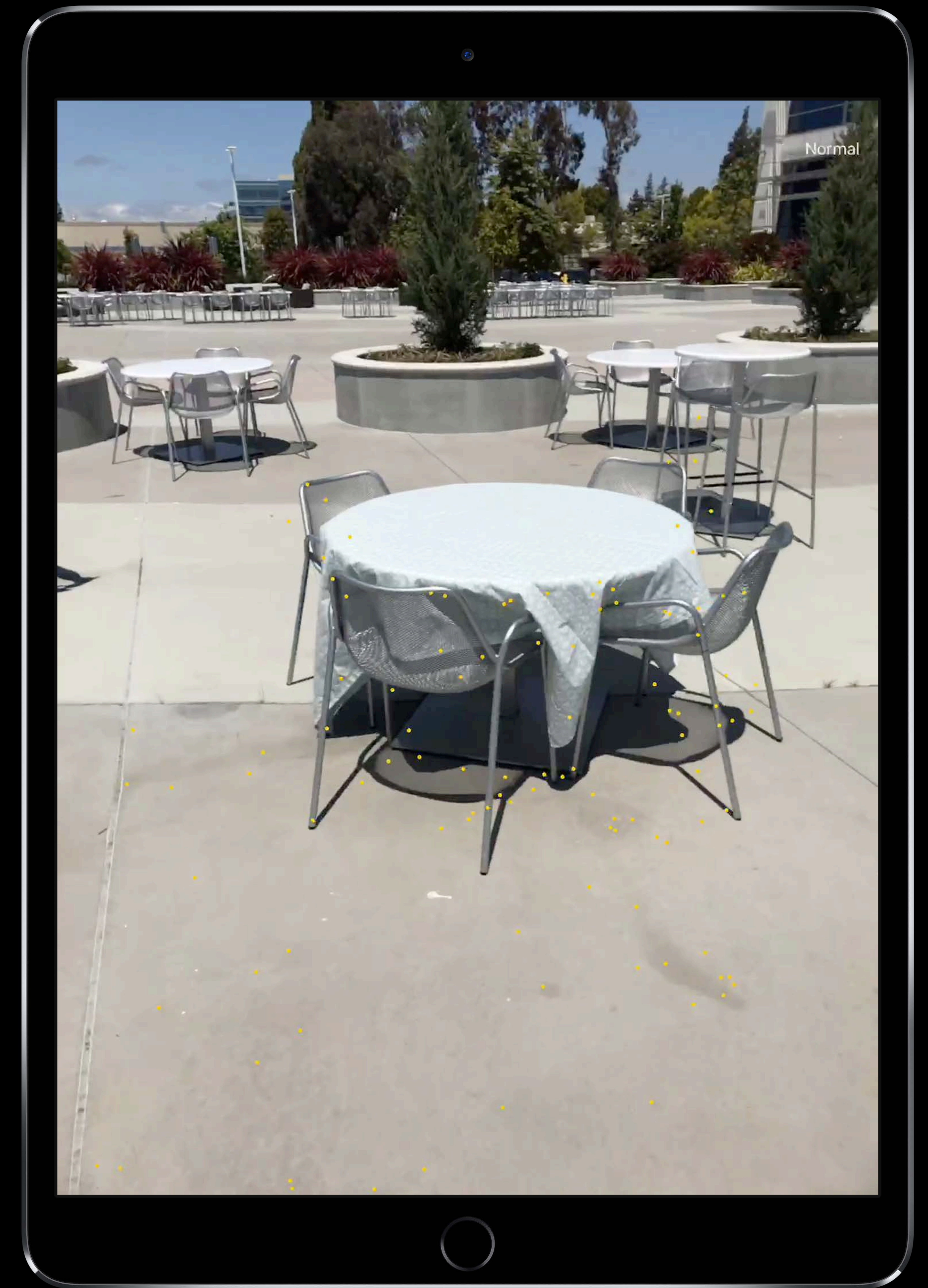


Image Tracking





Behind the Scenes

Localize the image



Behind the Scenes

Localize the image



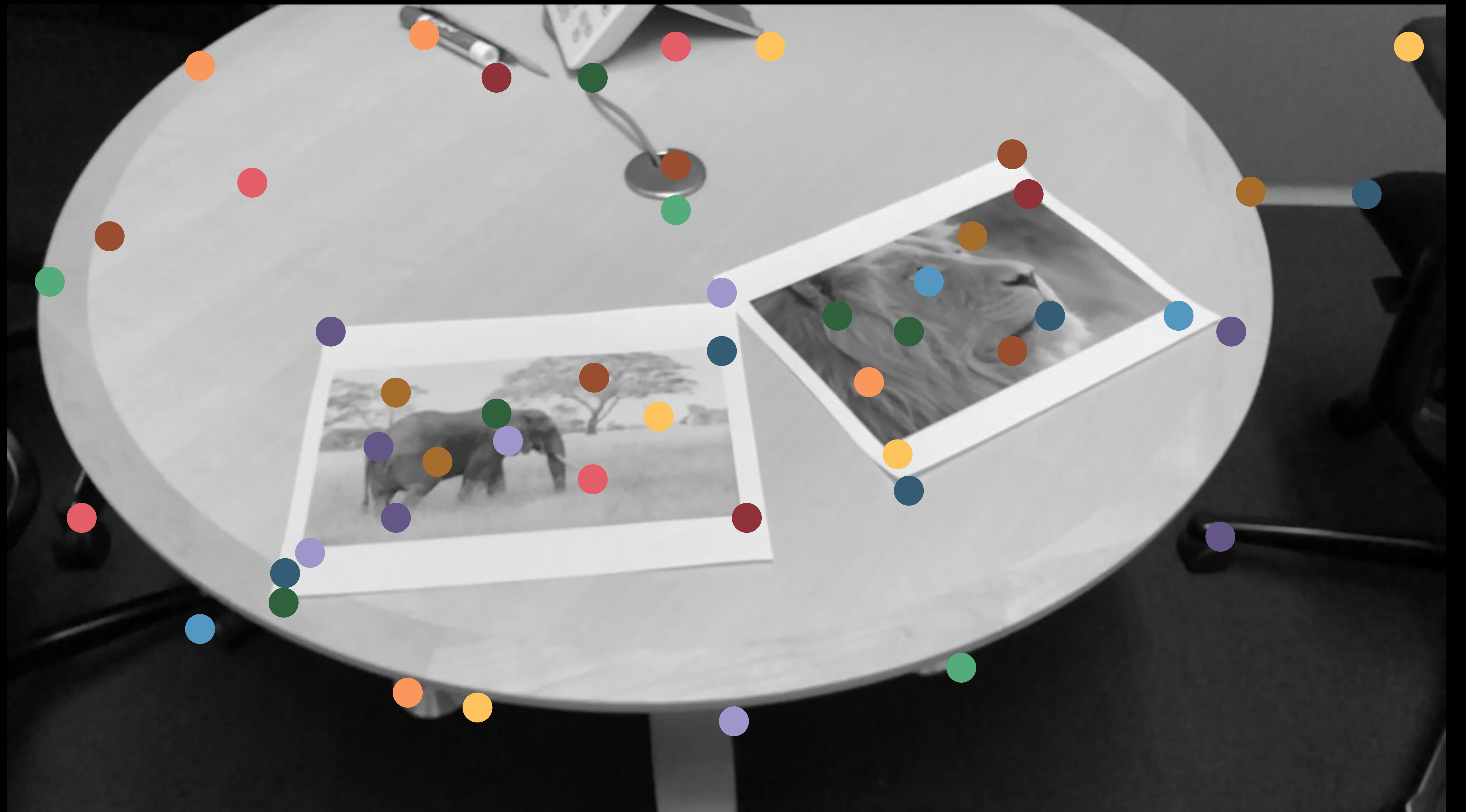
Behind the Scenes

Localize the image



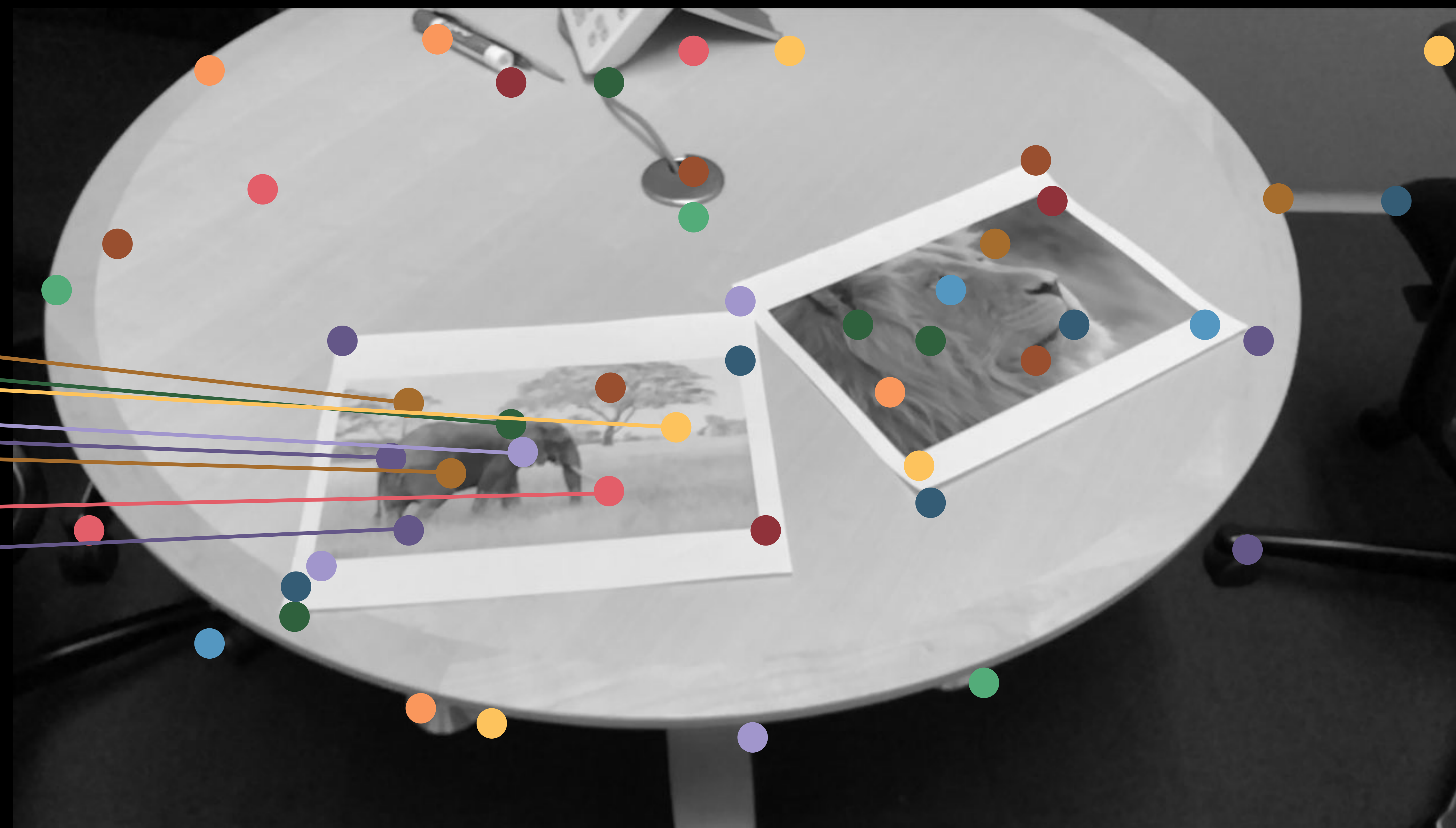
Behind the Scenes

Localize the image



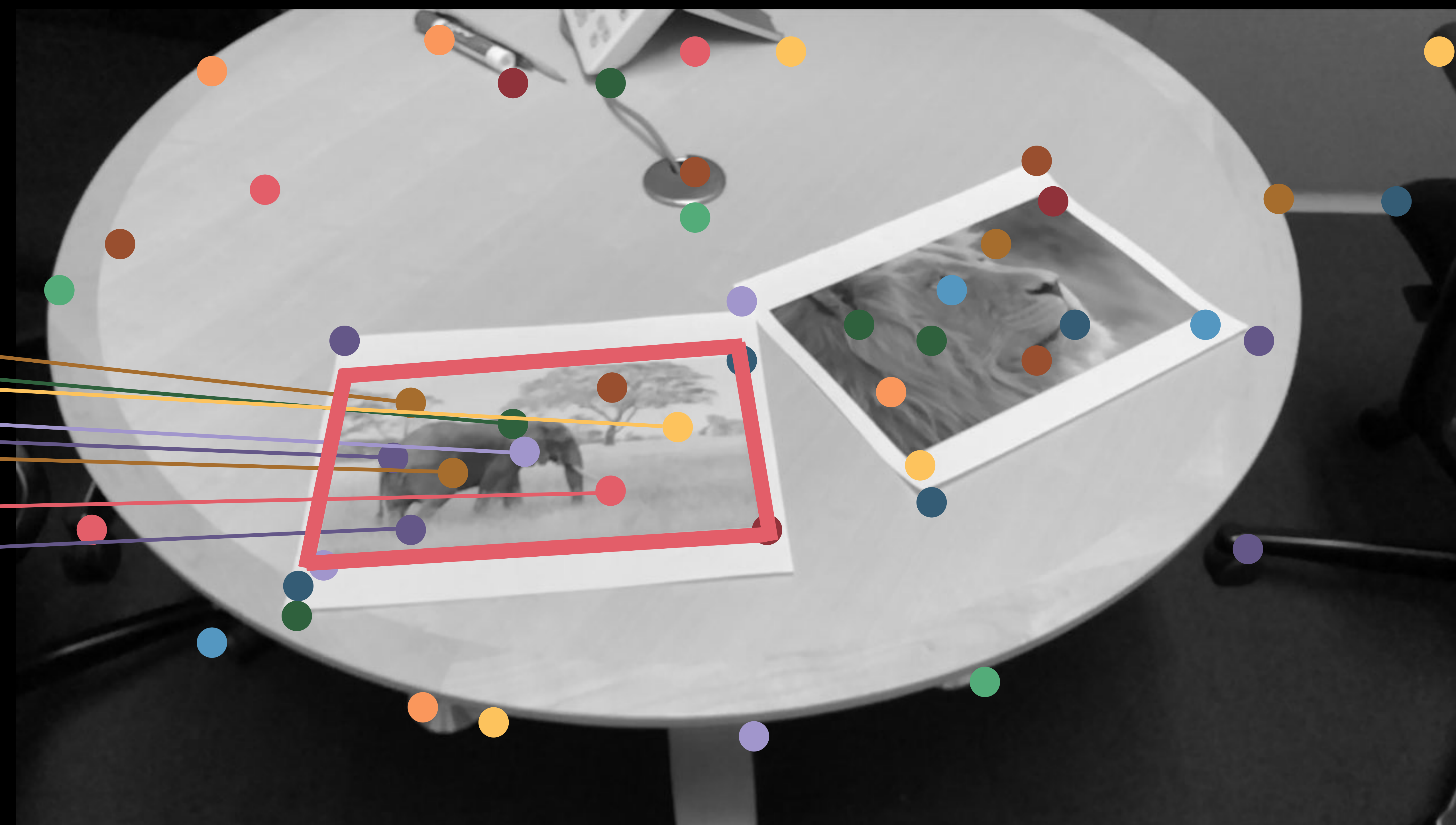
Behind the Scenes

Localize the image



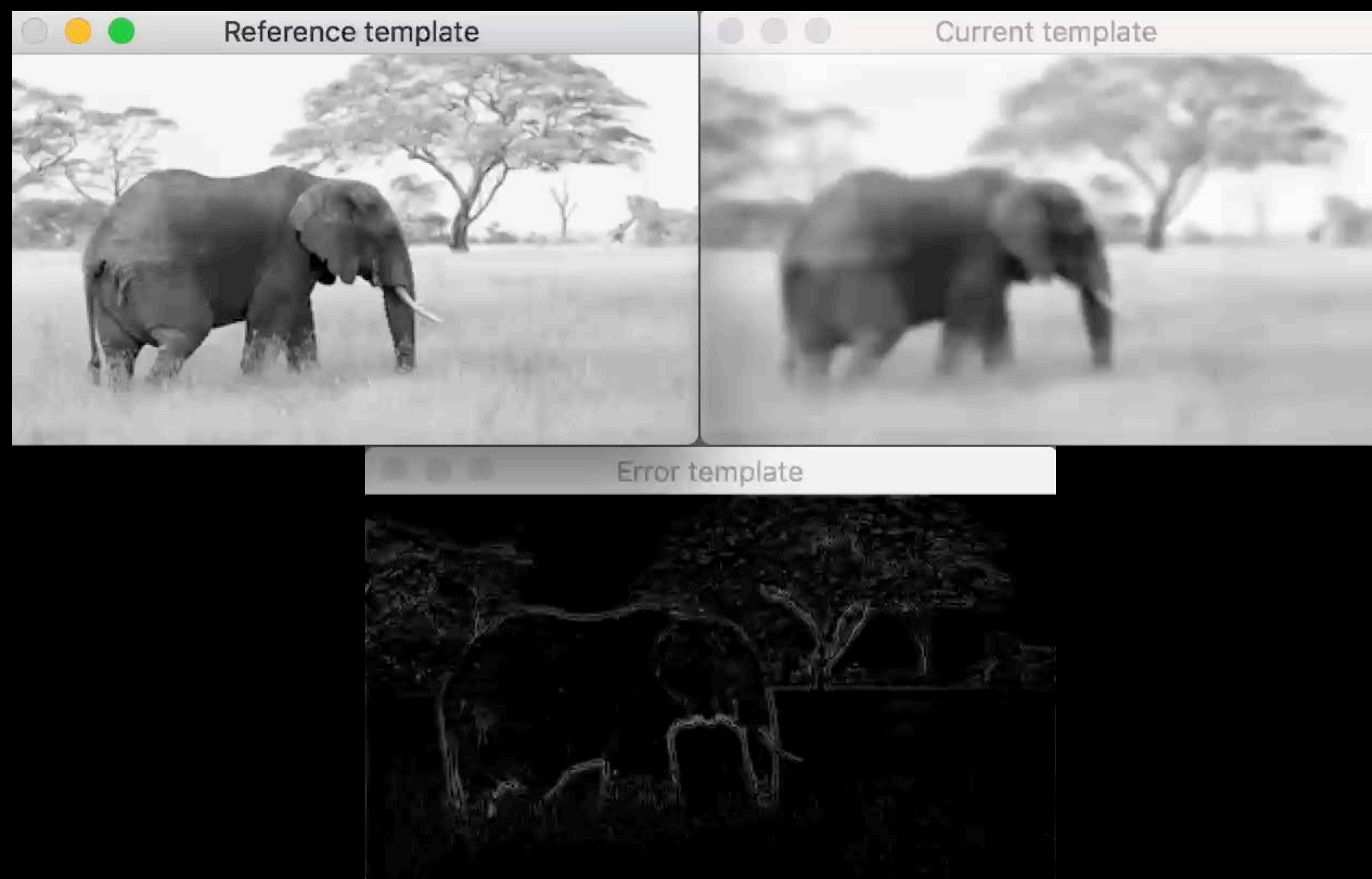
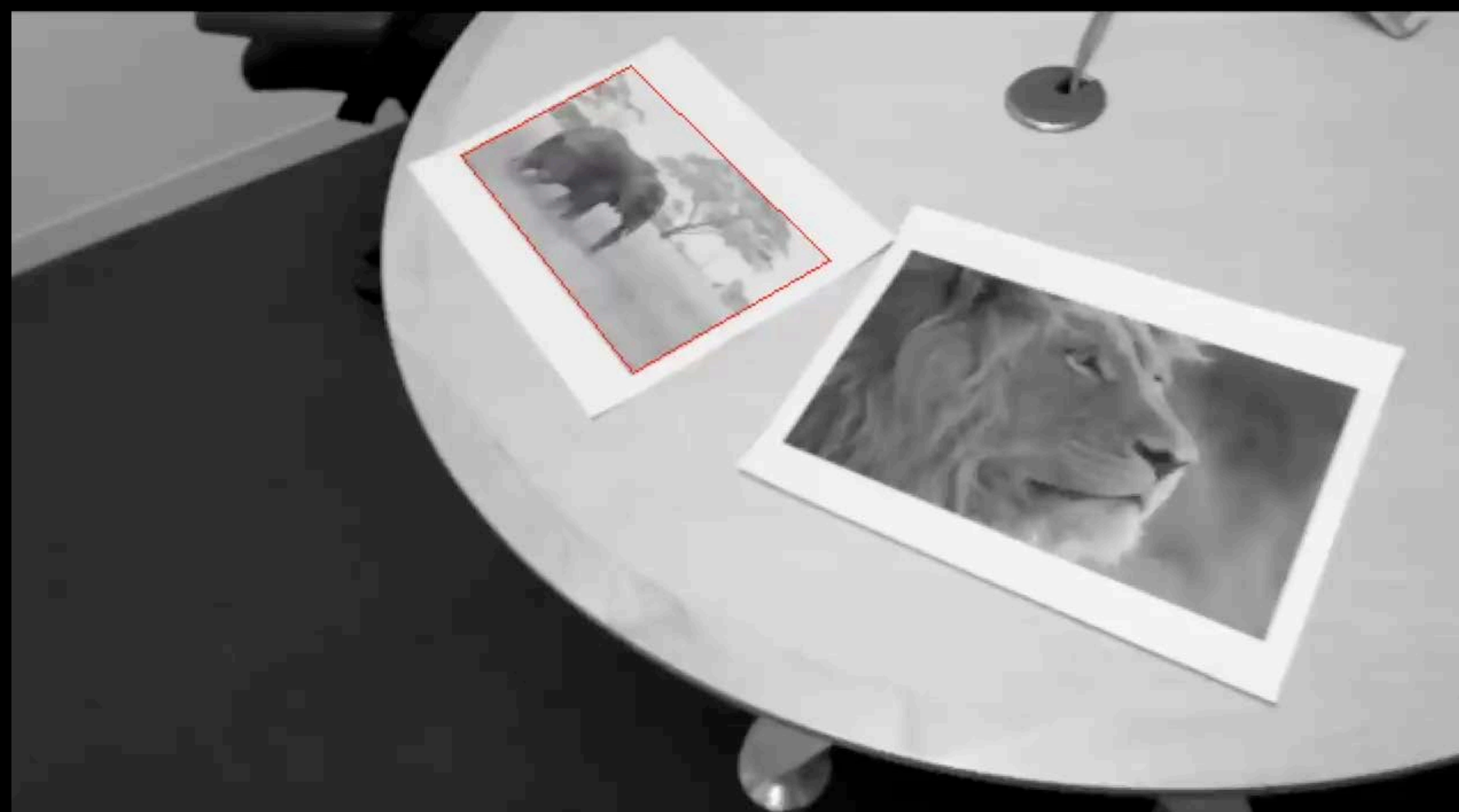
Behind the Scenes

Localize the image



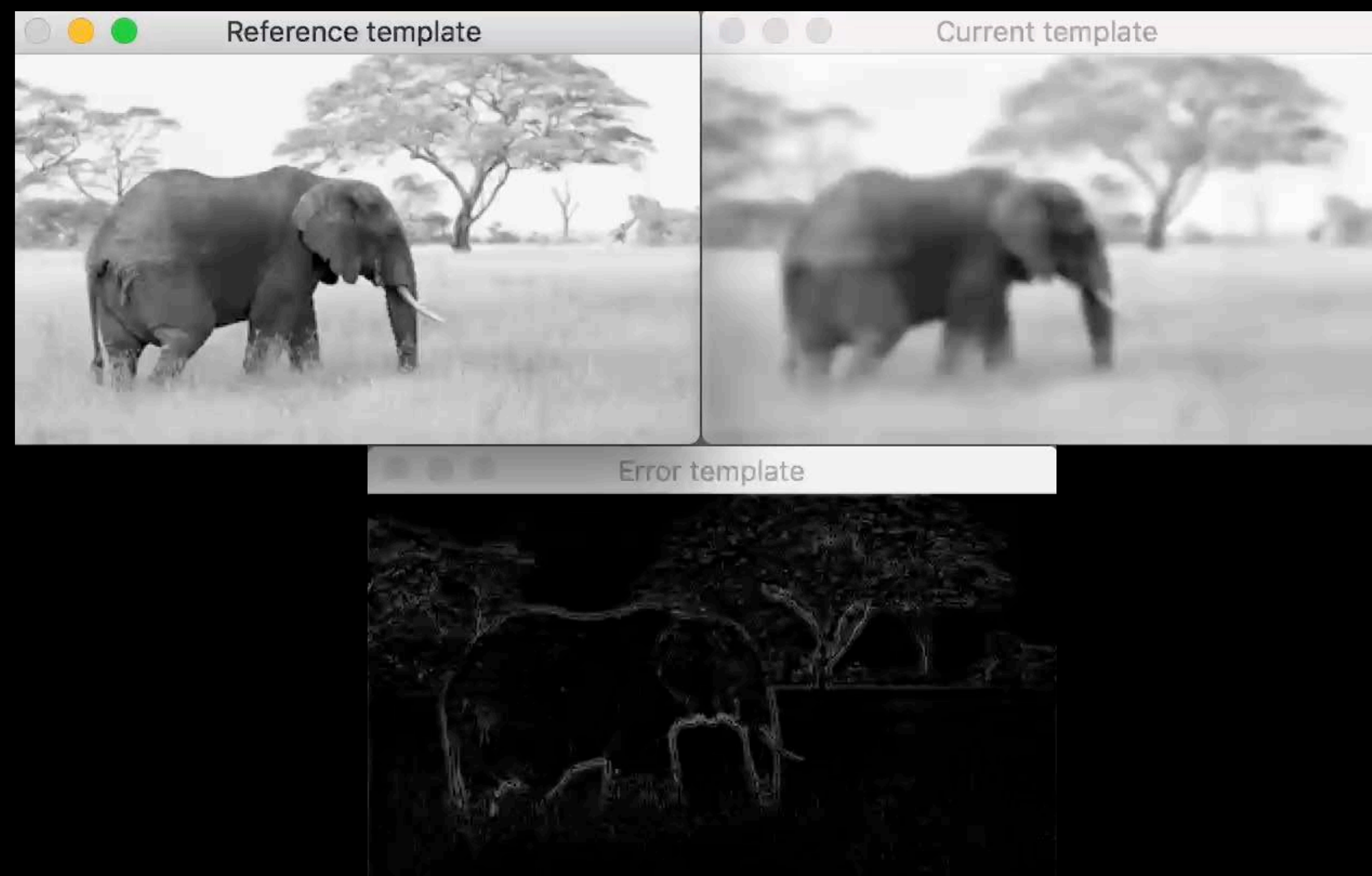
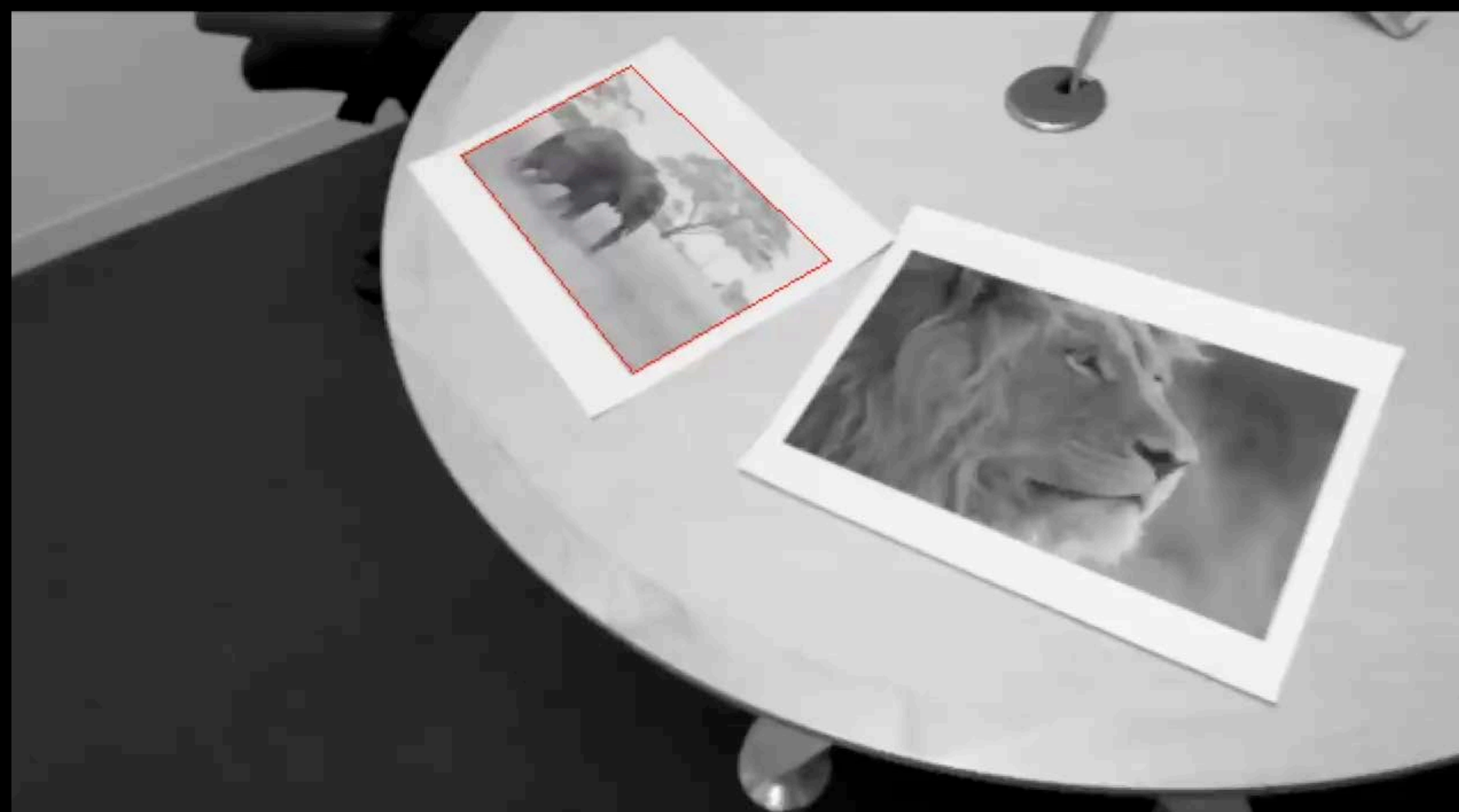
Behind the Scenes

Dense tracking



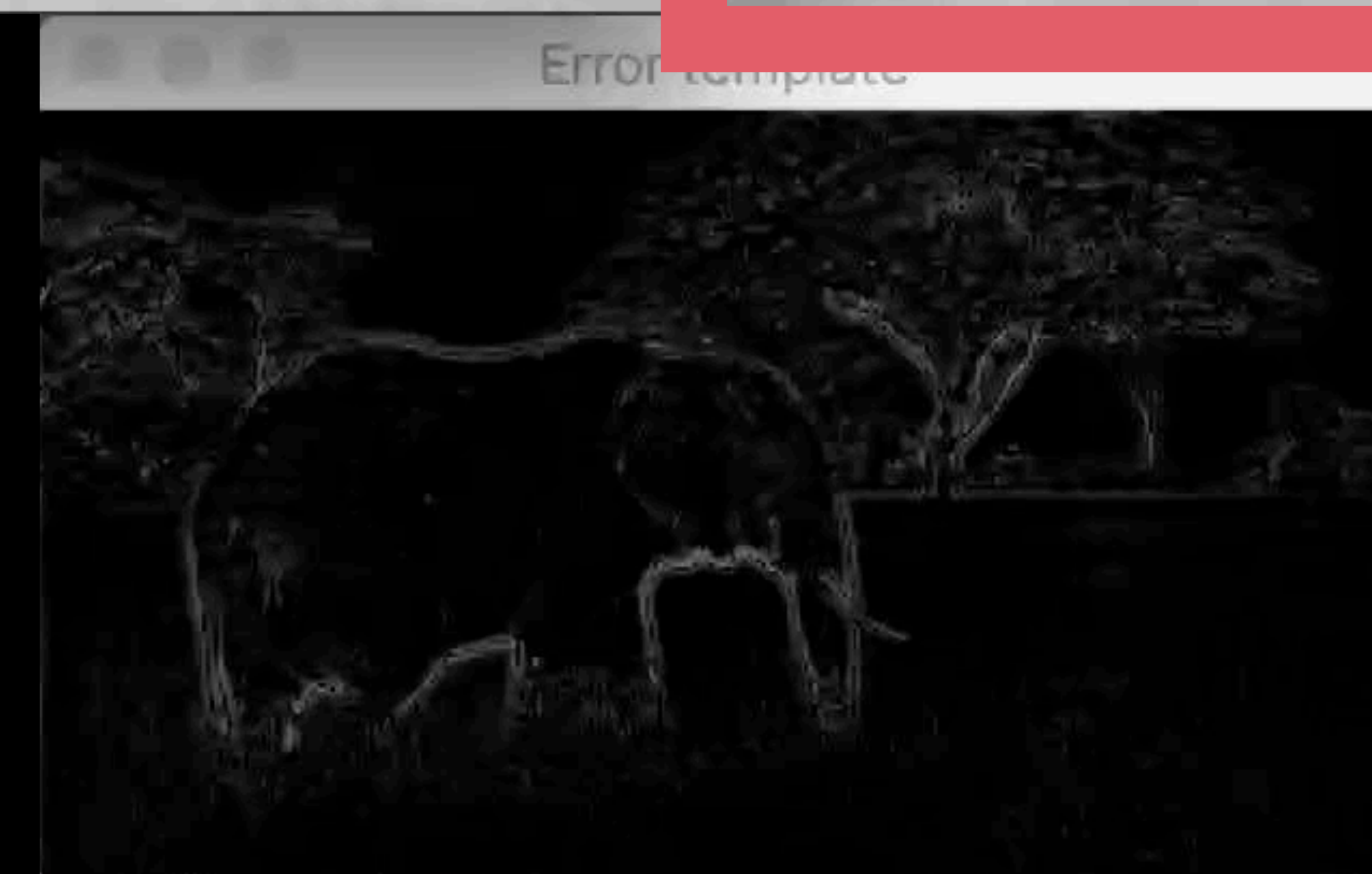
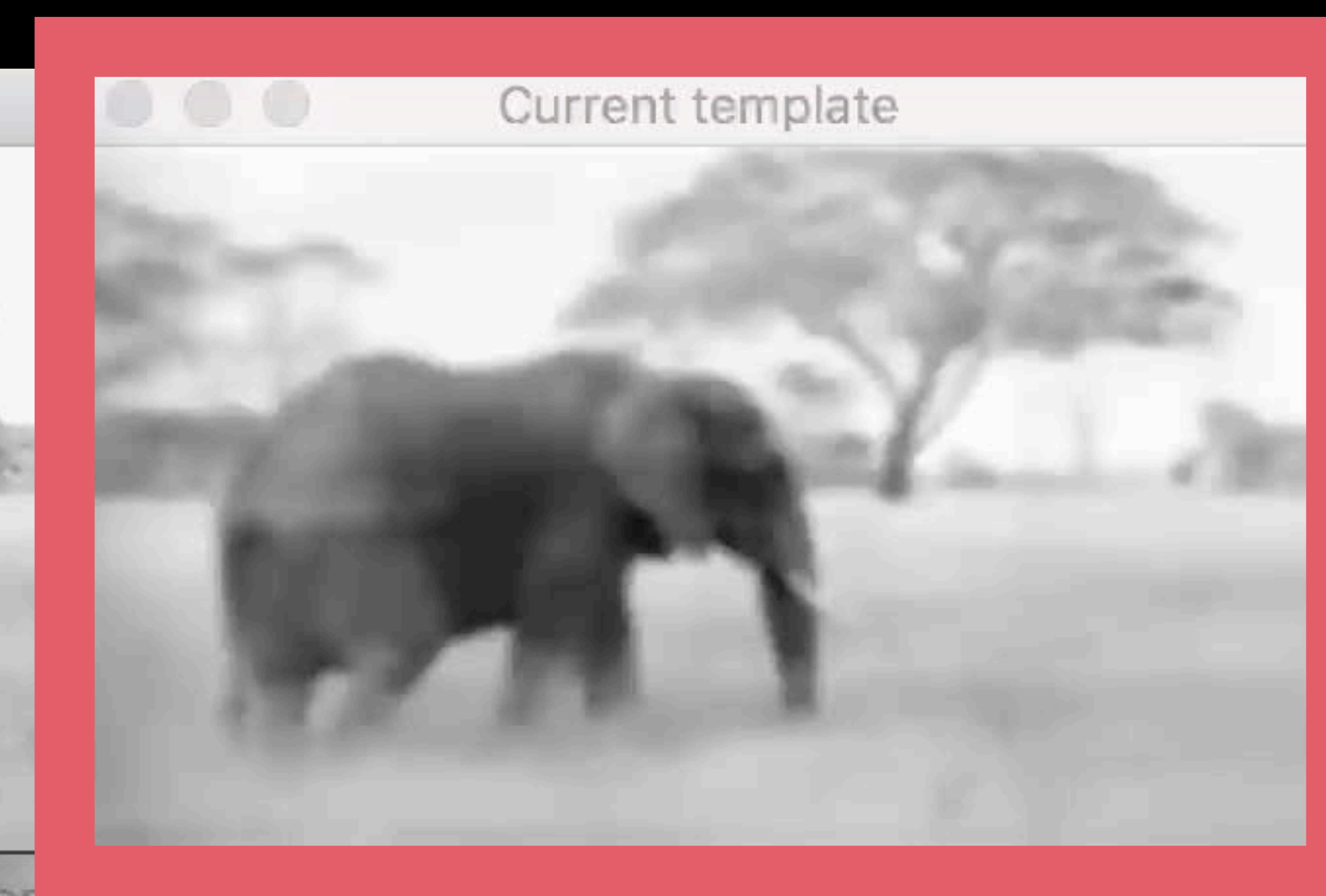
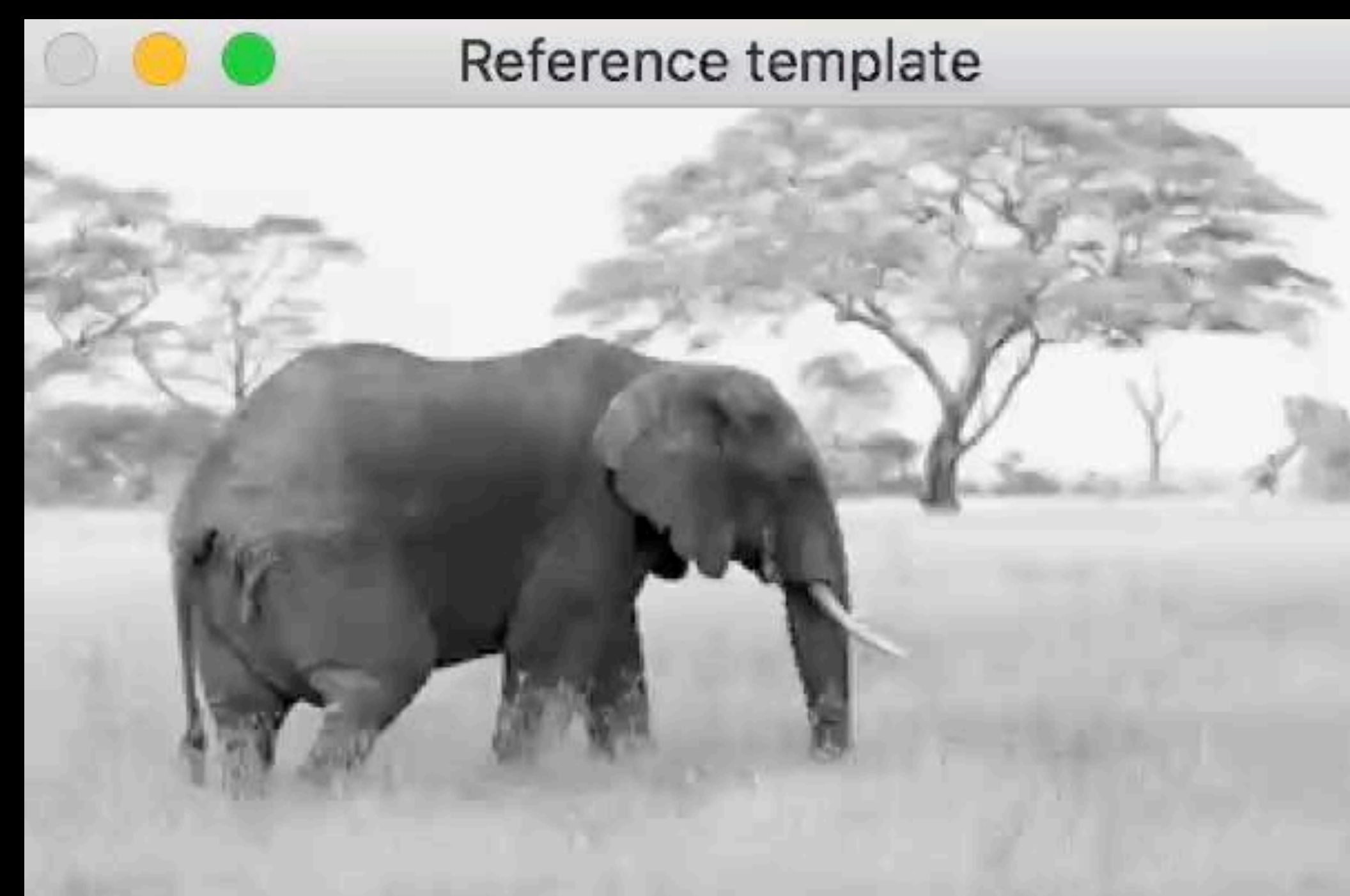
Behind the Scenes

Dense tracking



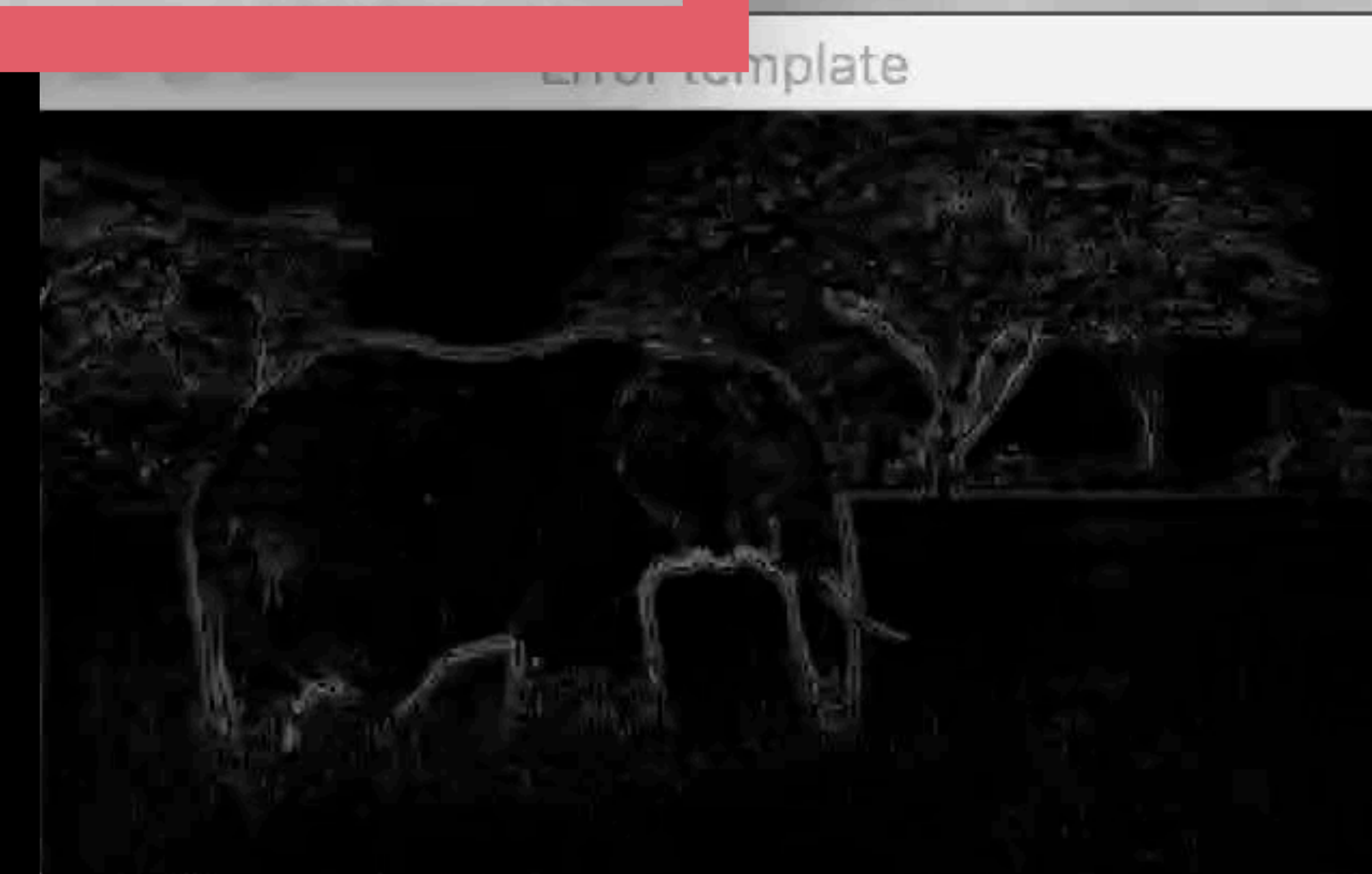
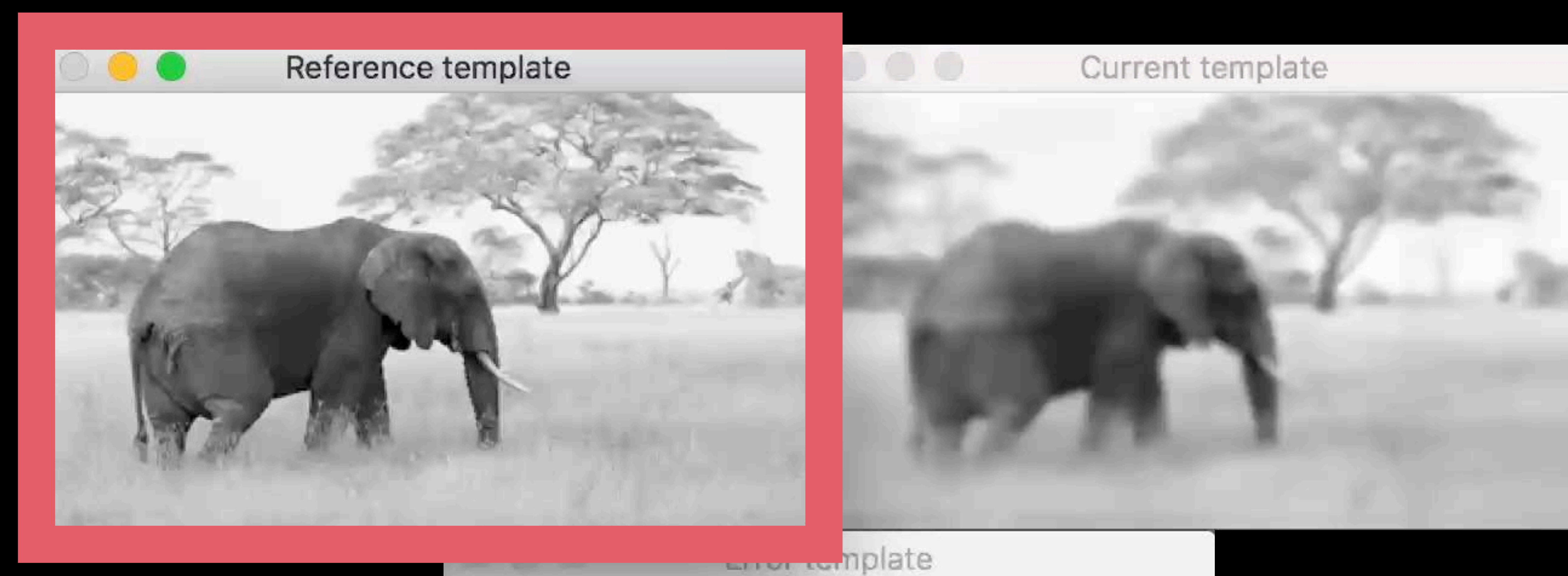
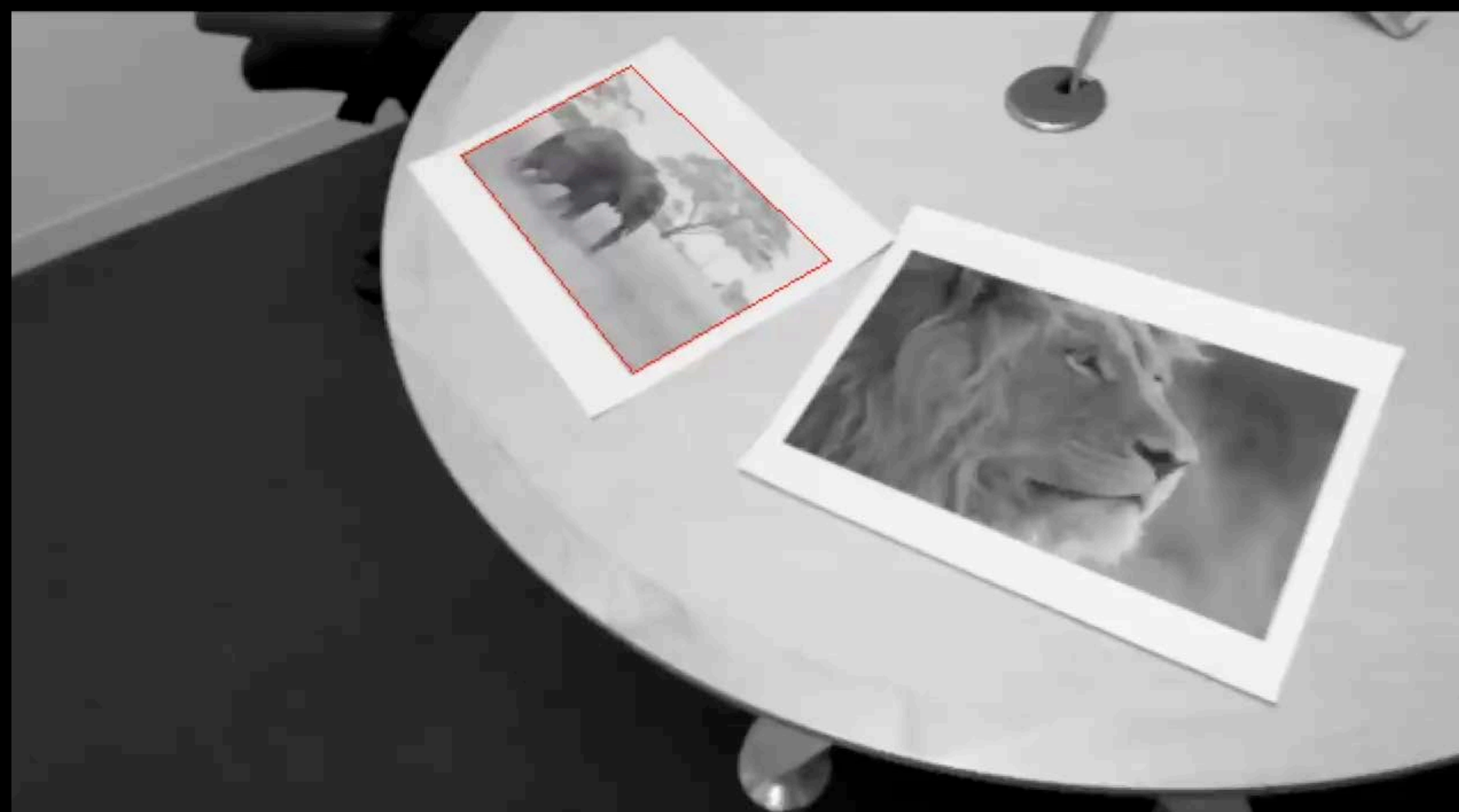
Behind the Scenes

Dense tracking



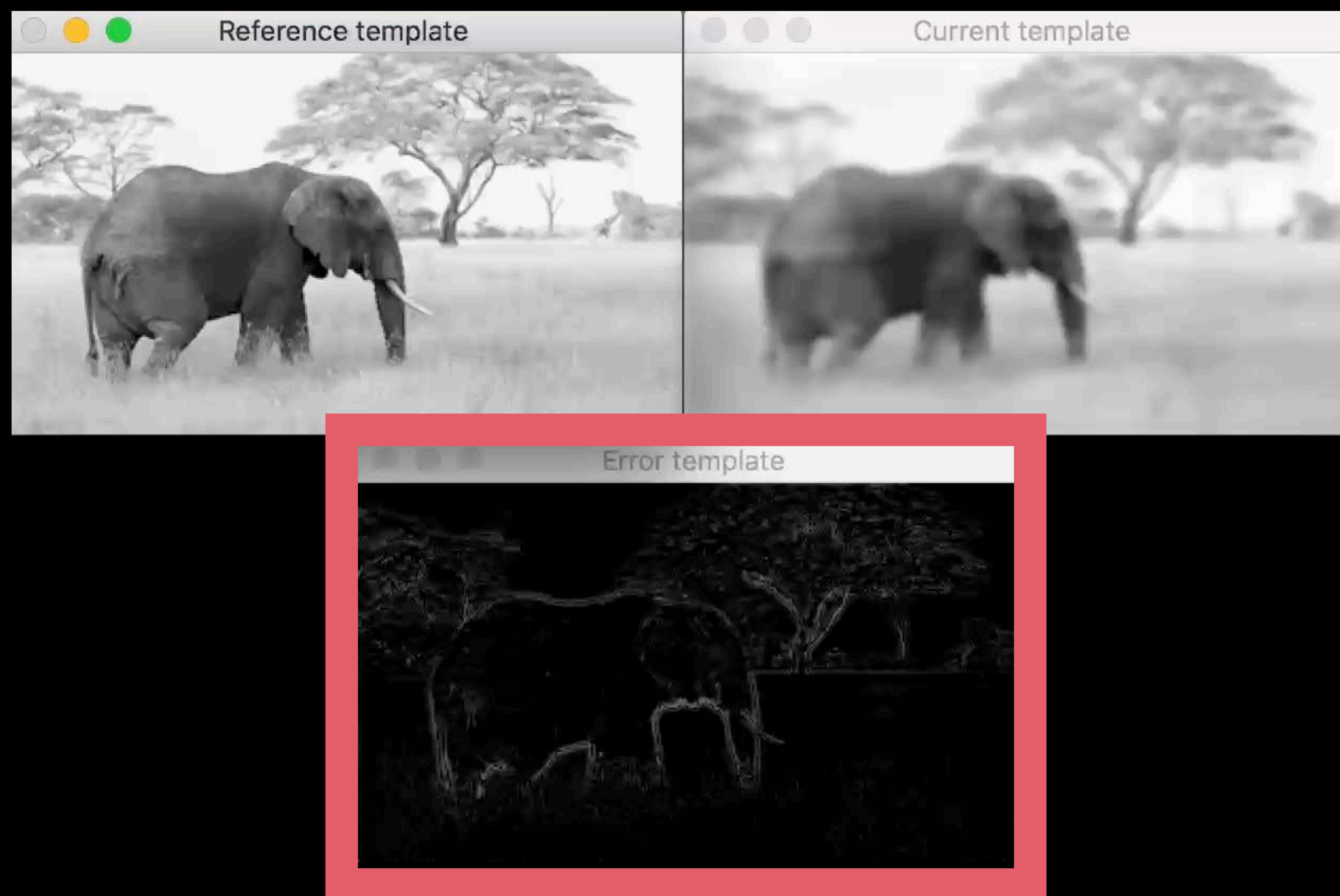
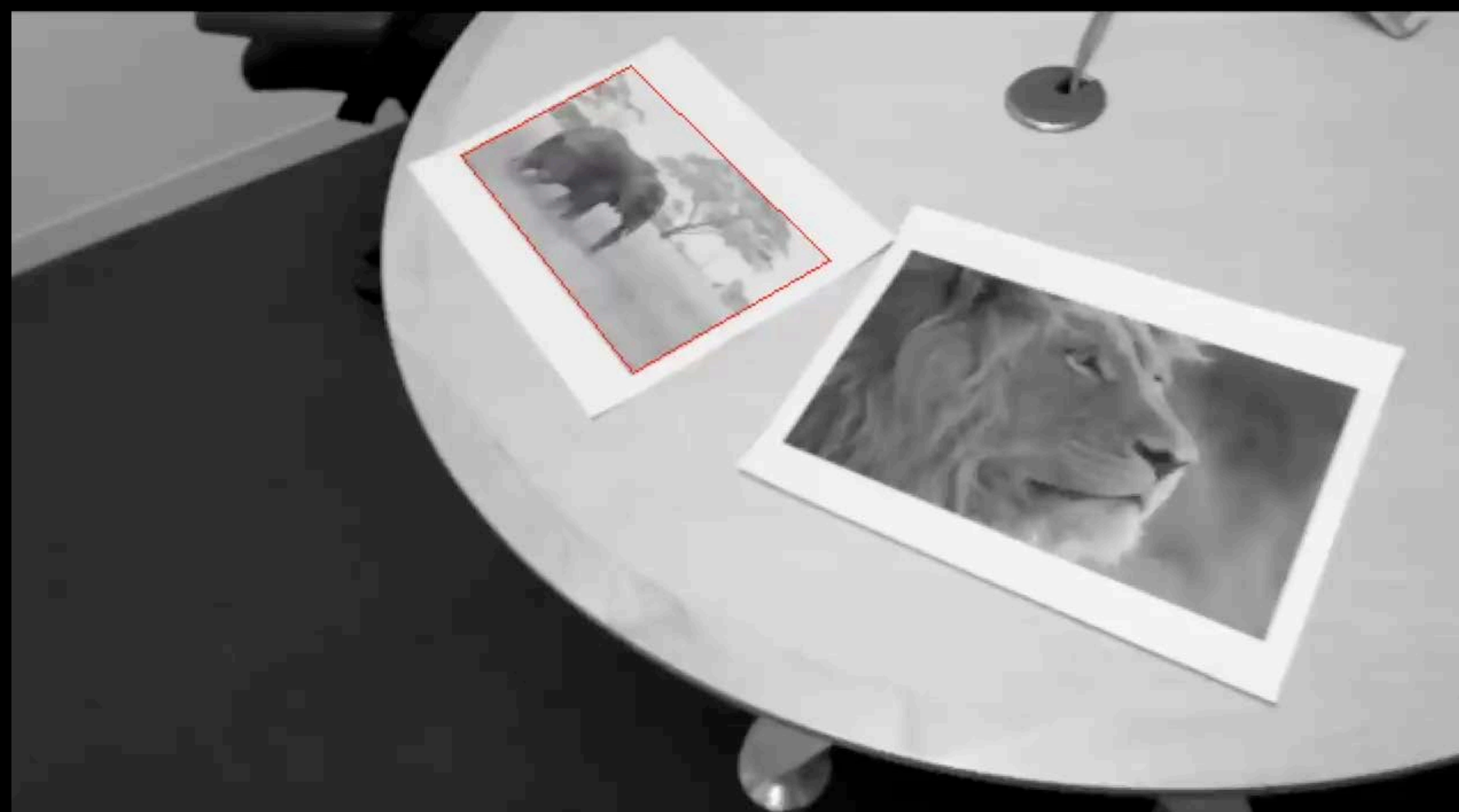
Behind the Scenes

Dense tracking



Behind the Scenes

Dense tracking



Behind the Scenes

Dense tracking

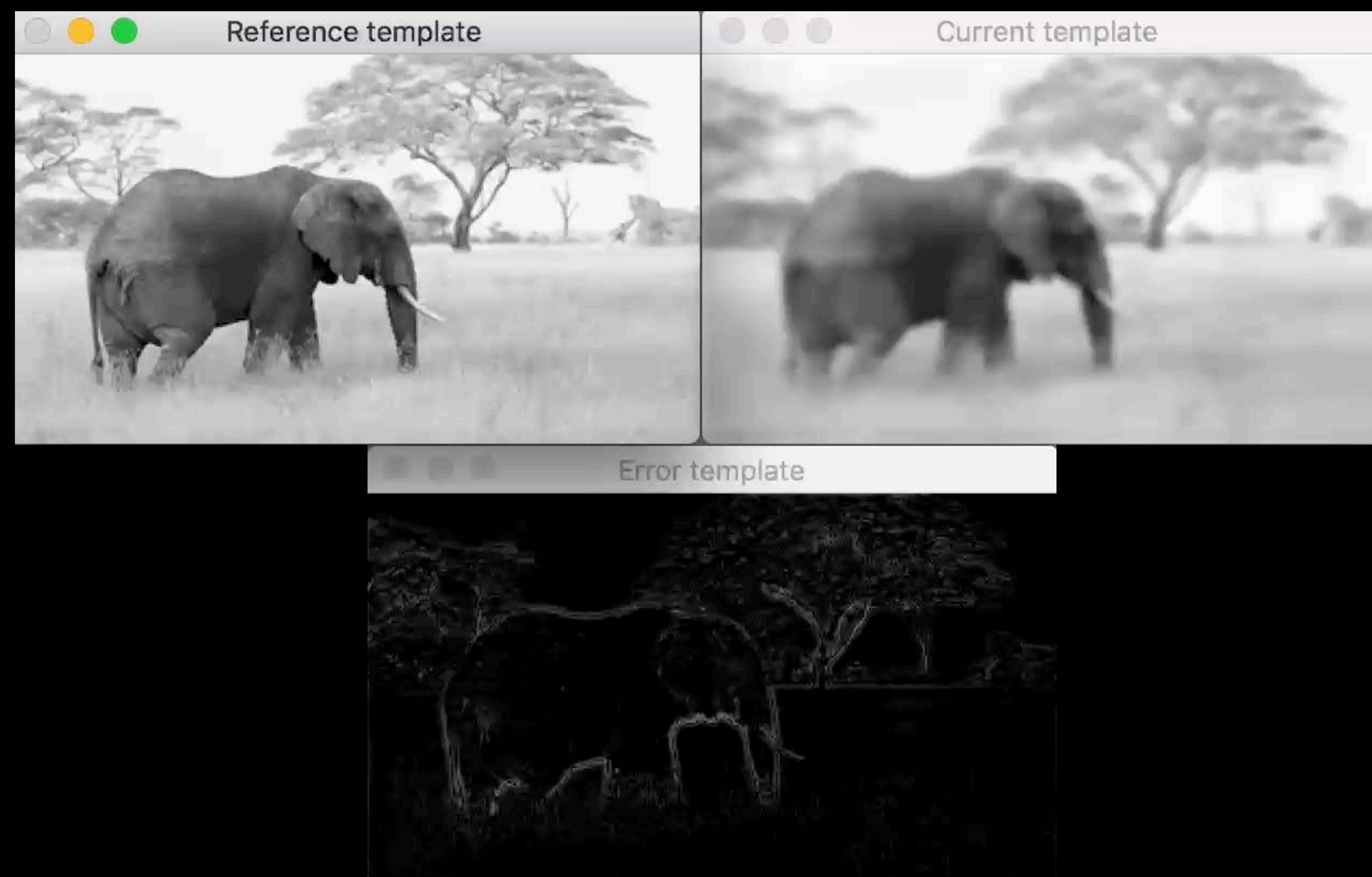
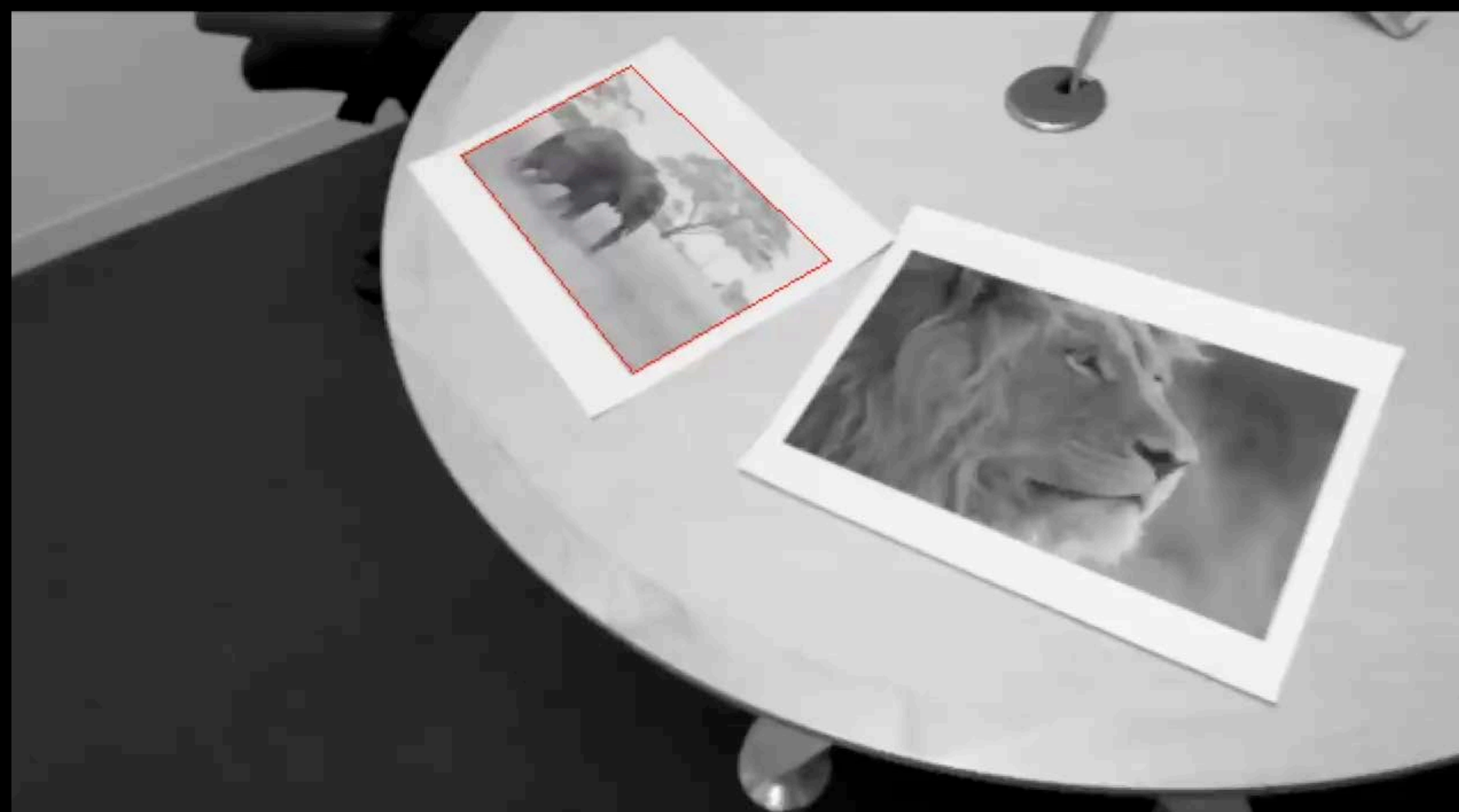


Image Tracking API

Reference Images

ARReferenceImage

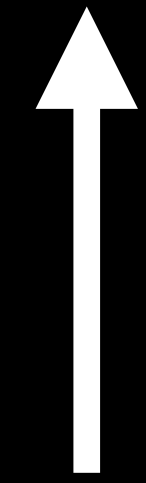


Image Tracking API

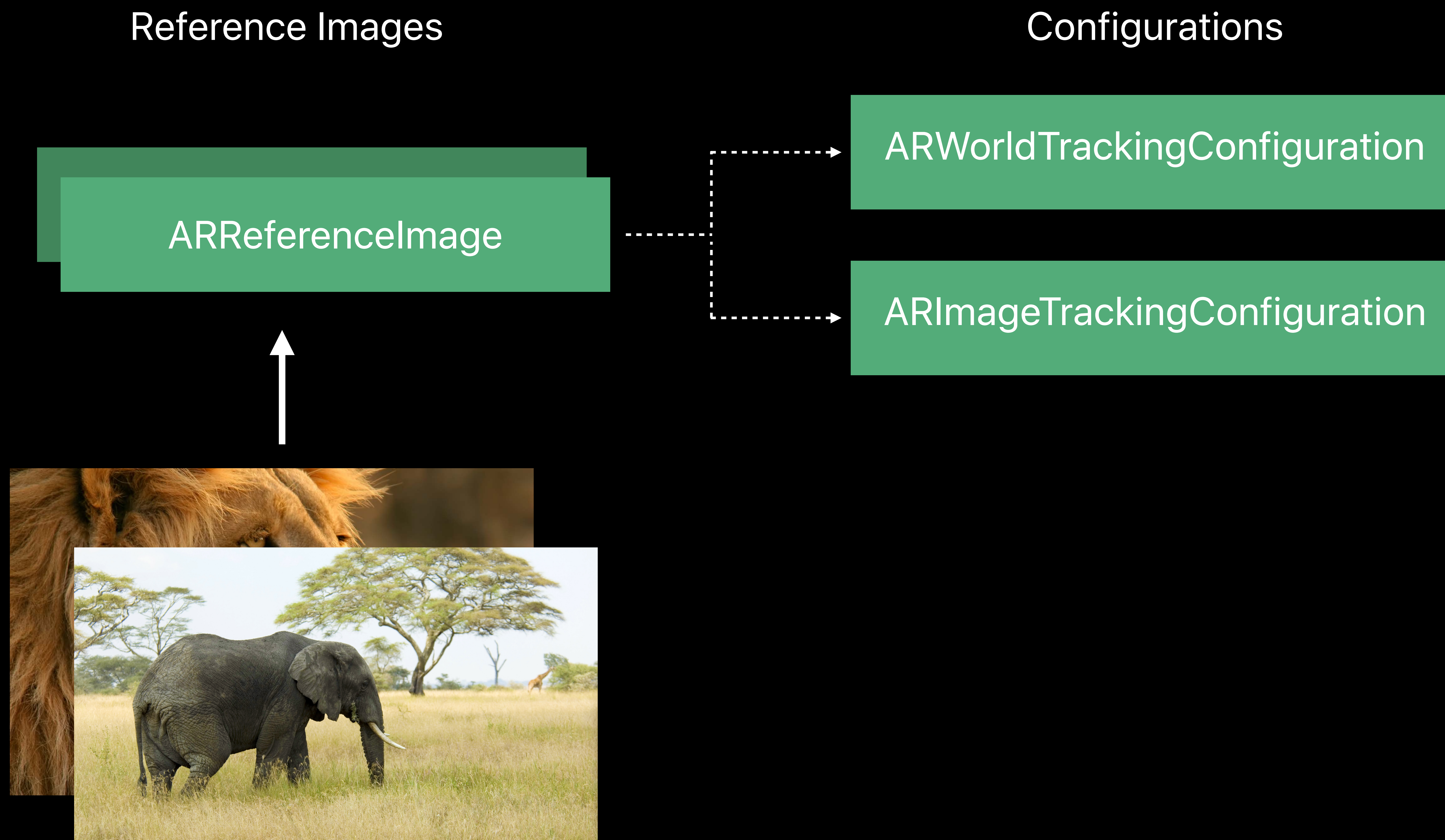
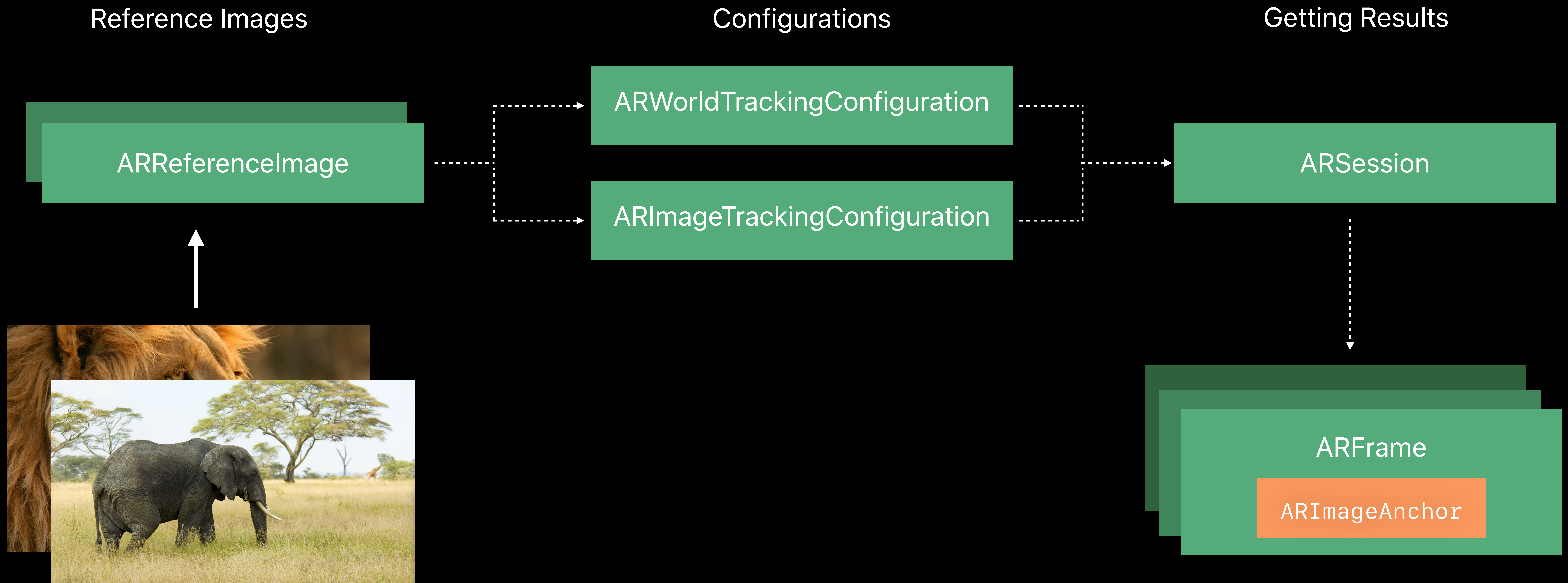
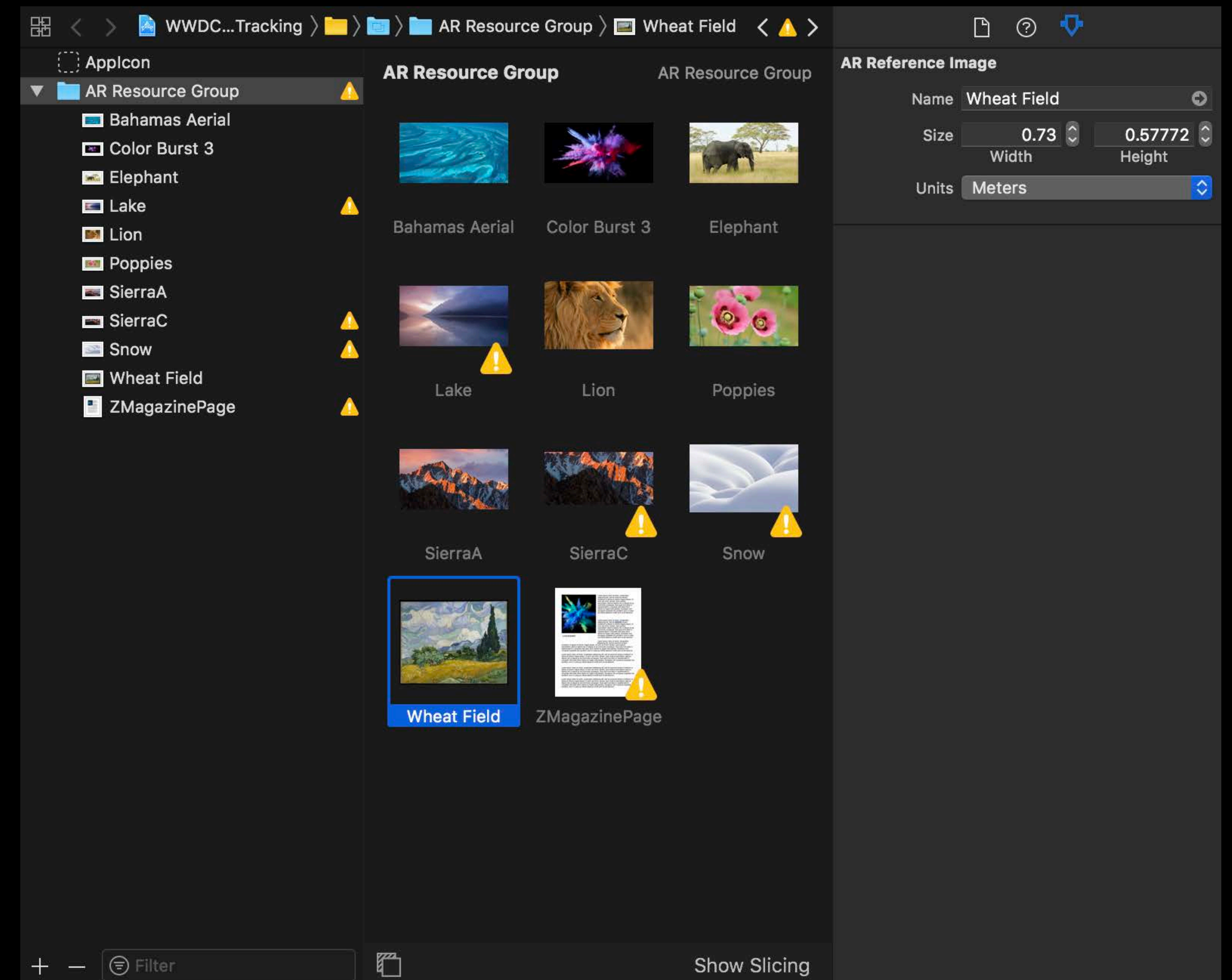


Image Tracking API



Adding Images as Assets

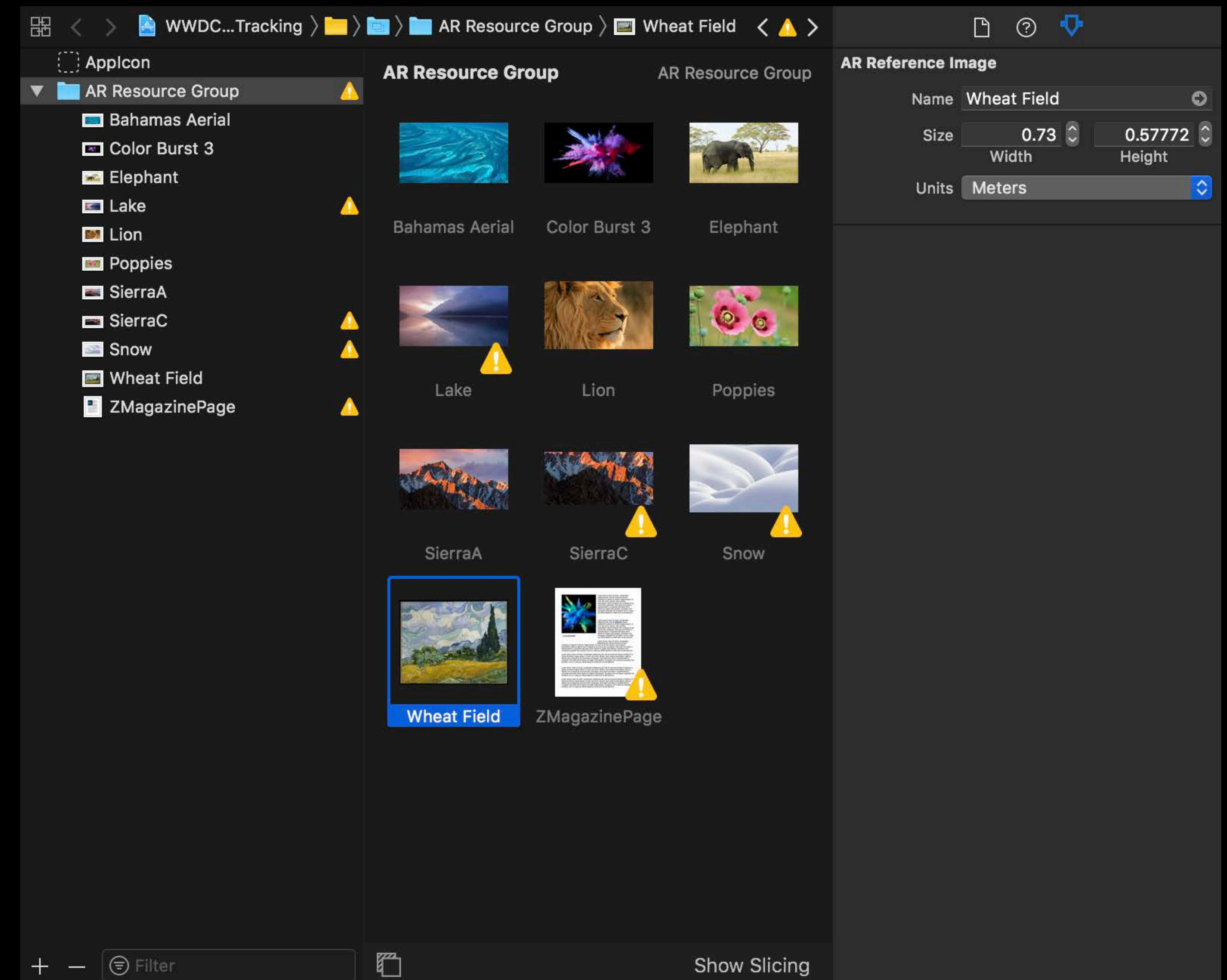
Create AR Resource Group



Adding Images as Assets

Create AR Resource Group

Drag images to be detected

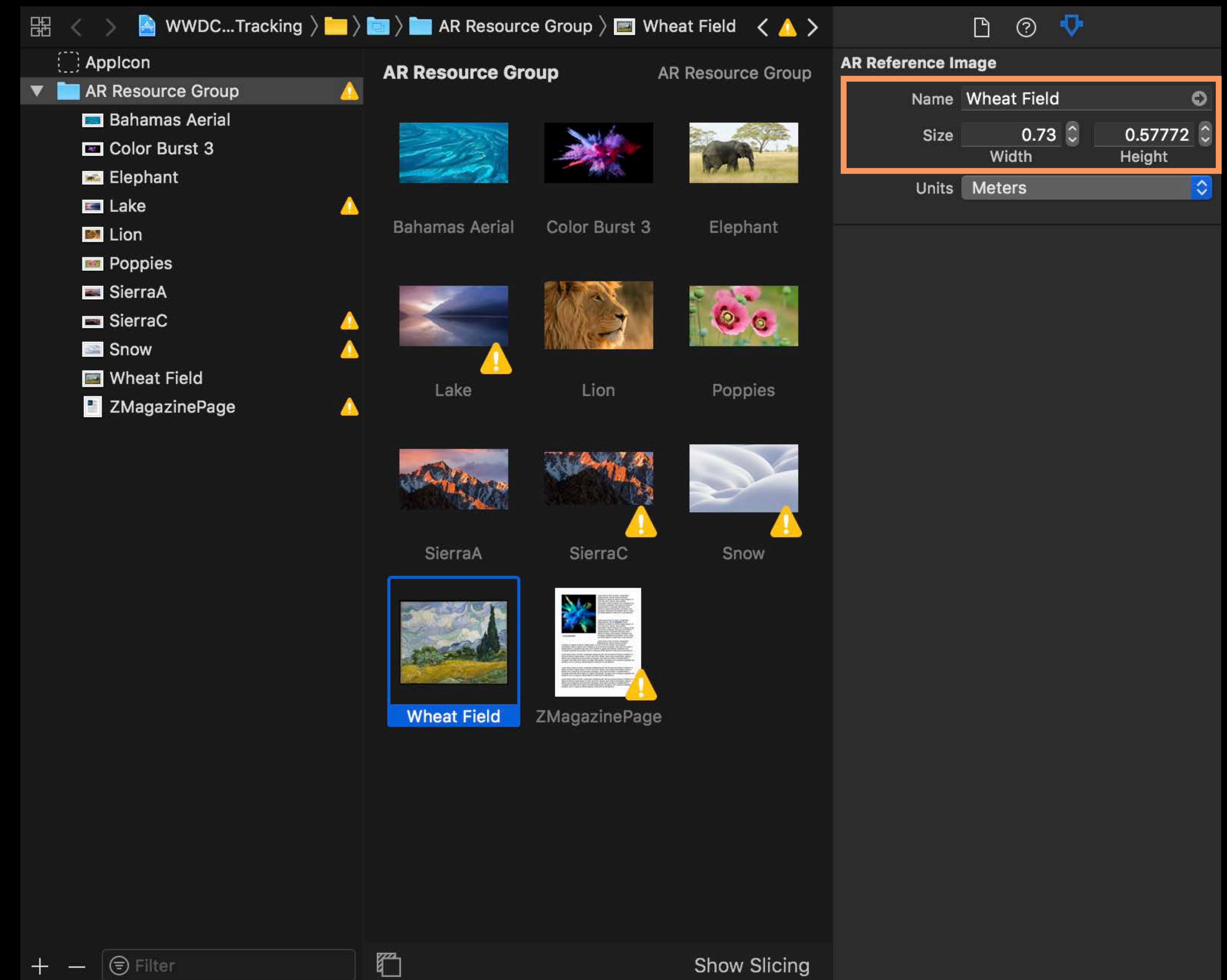


Adding Images as Assets

Create AR Resource Group

Drag images to be detected

Set physical dimension for images



Setting Physical Dimension for Images

Physical image size must be known



Setting Physical Dimension for Images

Physical image size must be known

Allows content to be in physical dimension



Setting Physical Dimension for Images

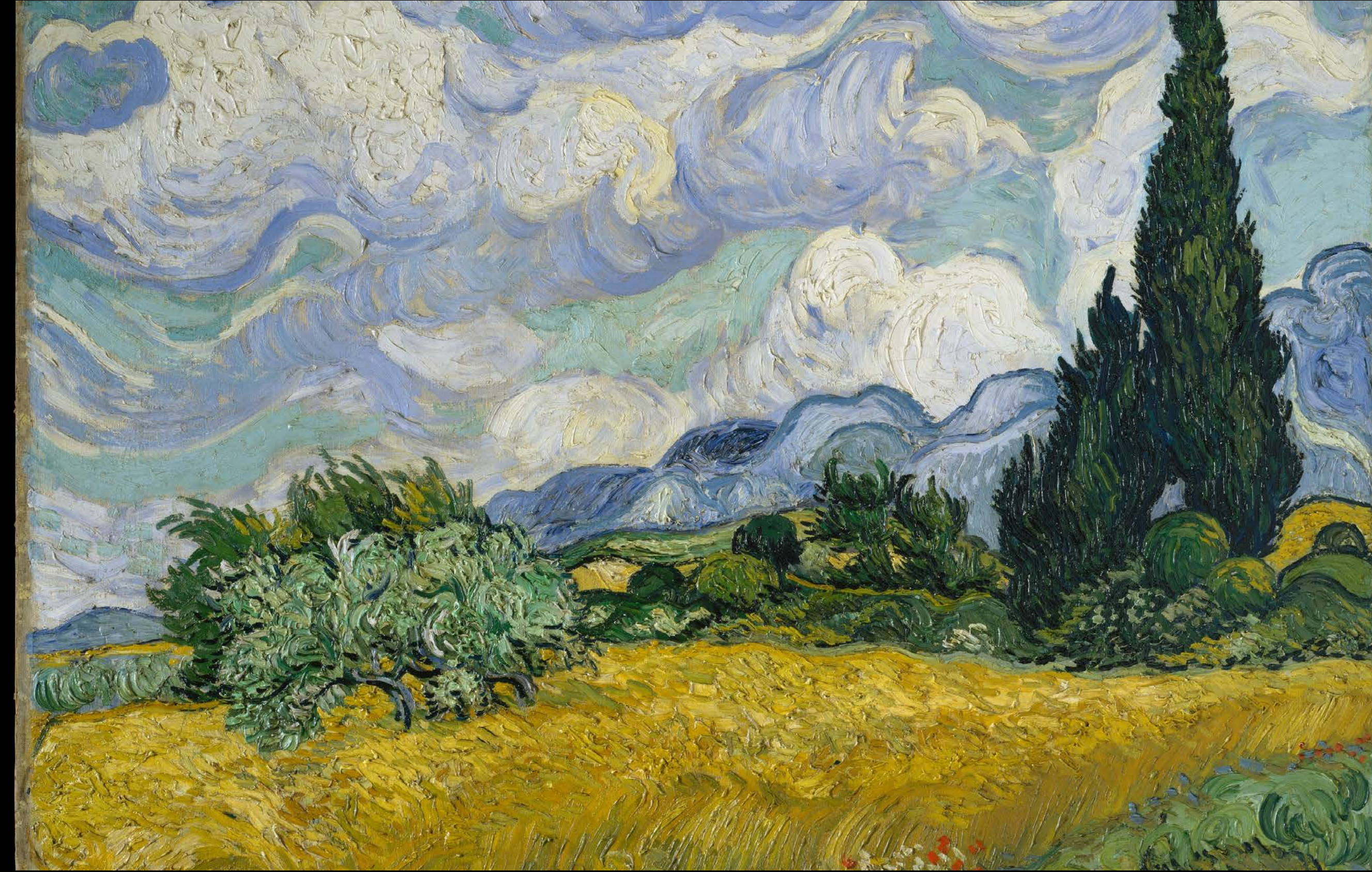
Physical image size must be known

Allows content to be in physical dimension

Consistent with world tracking data



Good Images to Track



Good Images to Track

High texture

High local contrast

Well distributed histogram

No repetitive structures



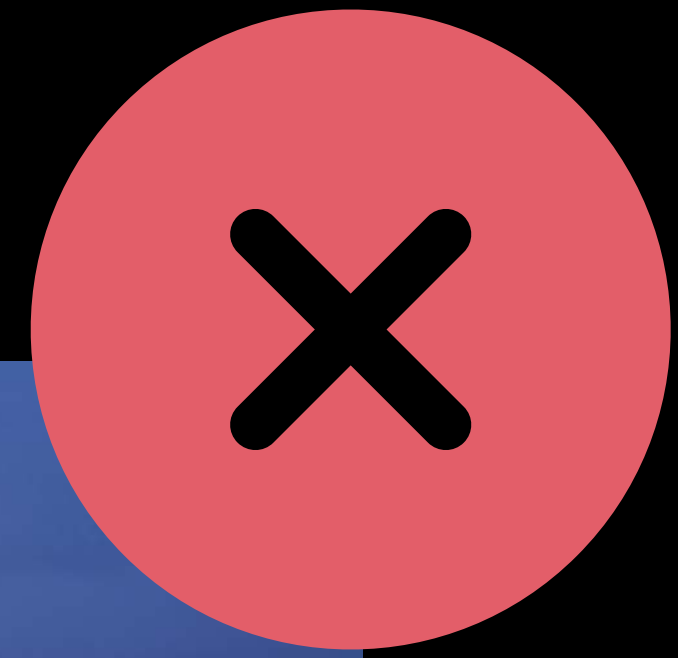
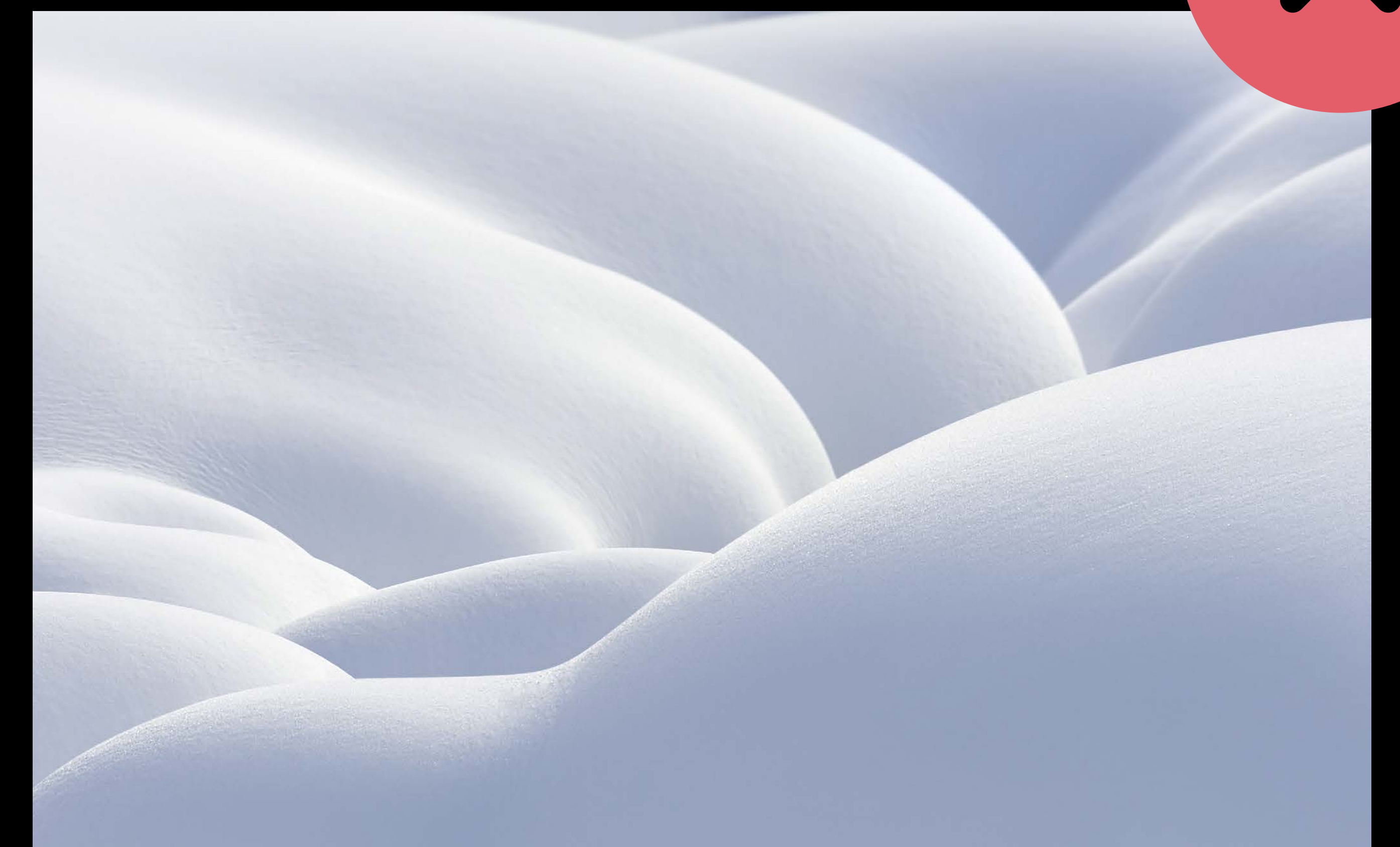
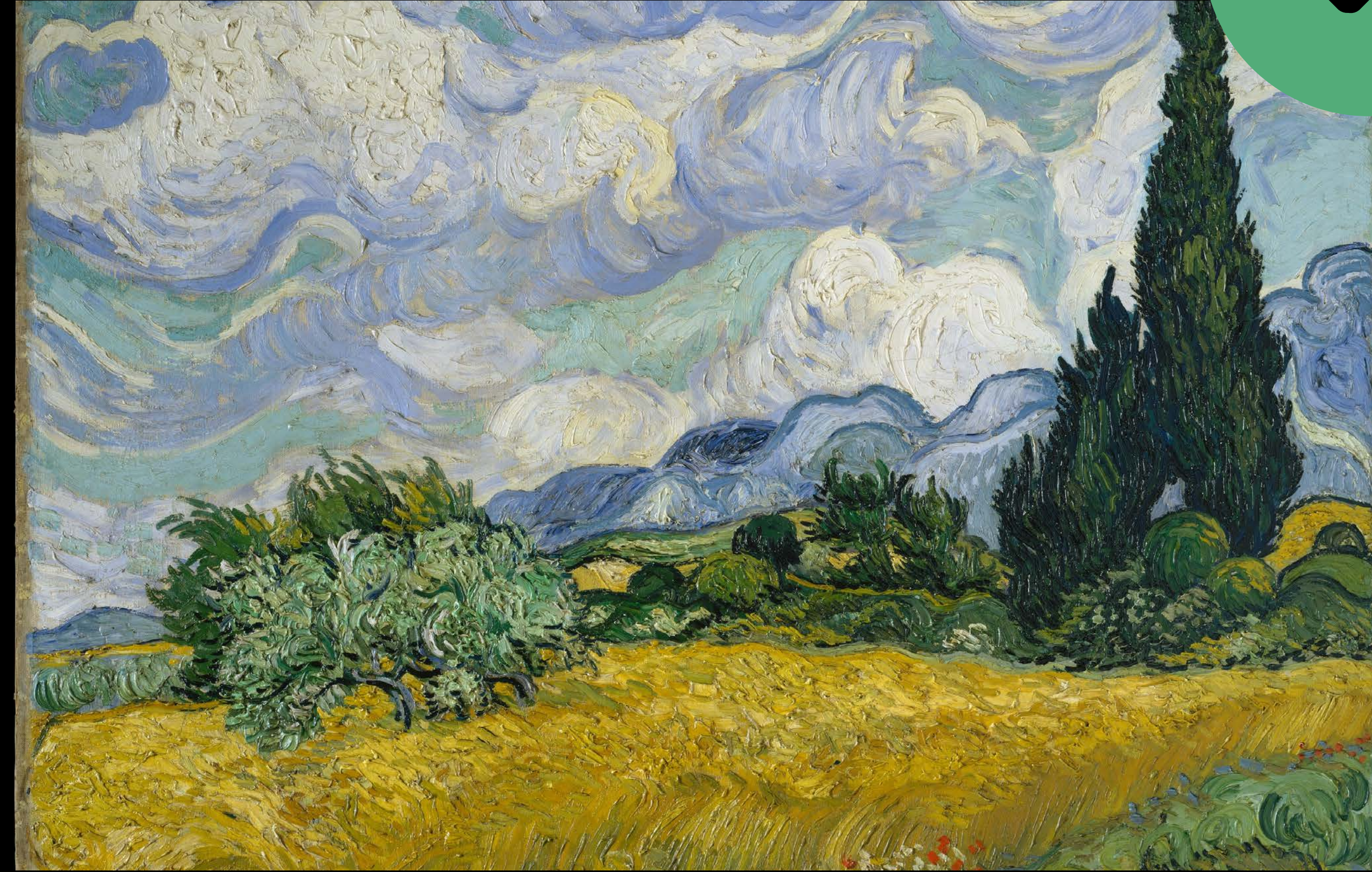
Good Images to Track

High texture

High local contrast

Well distributed histogram

No repetitive structures



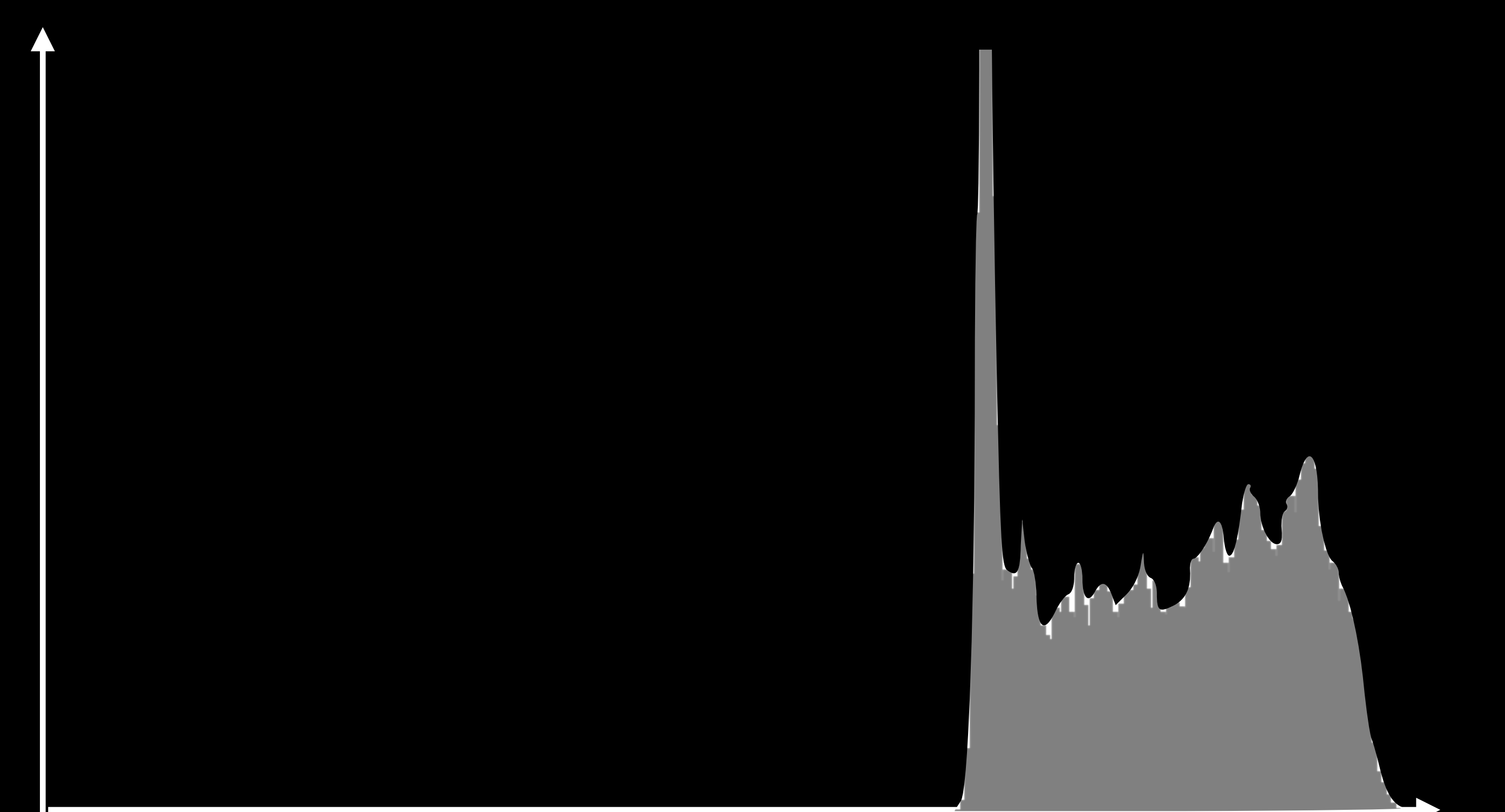
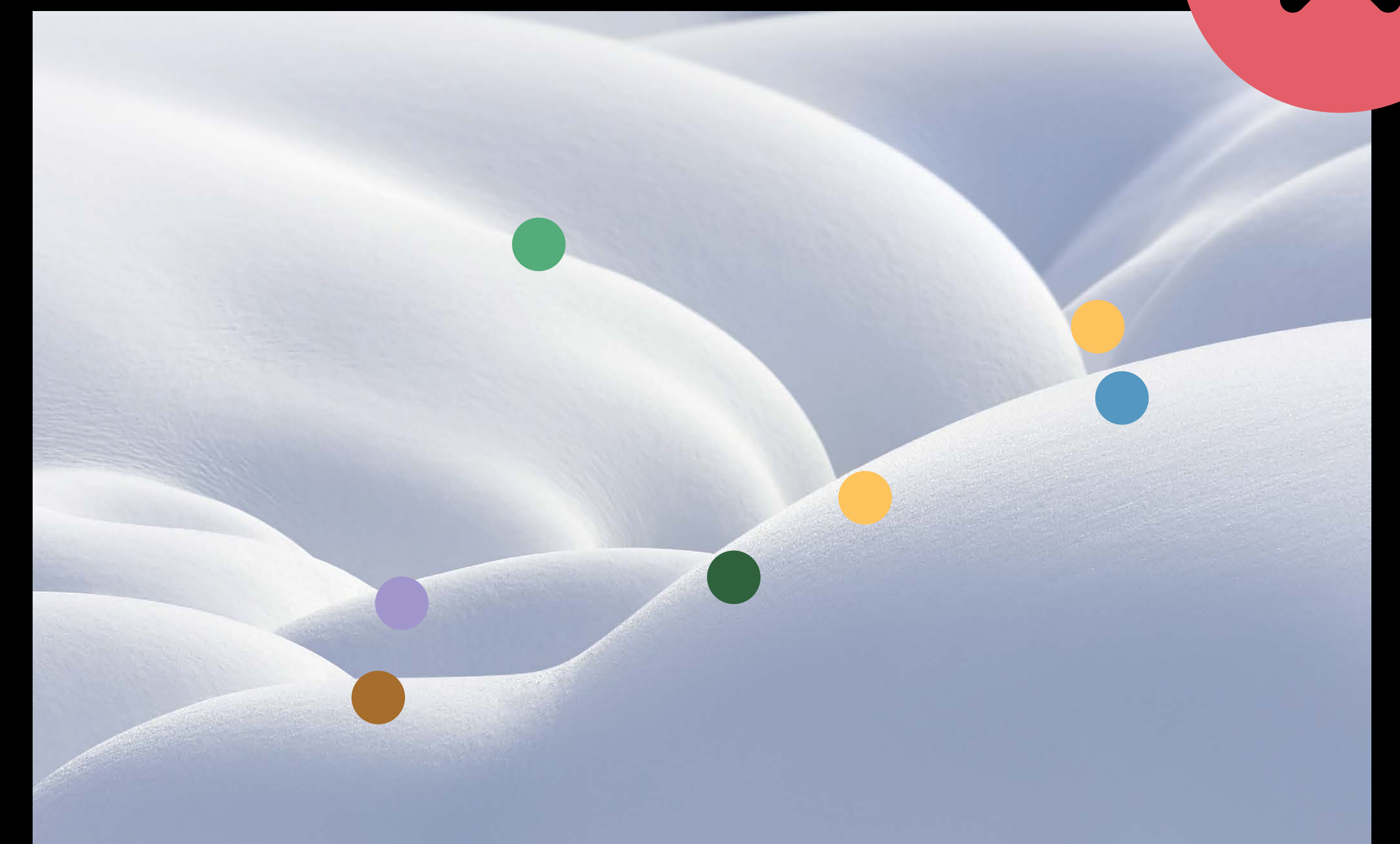
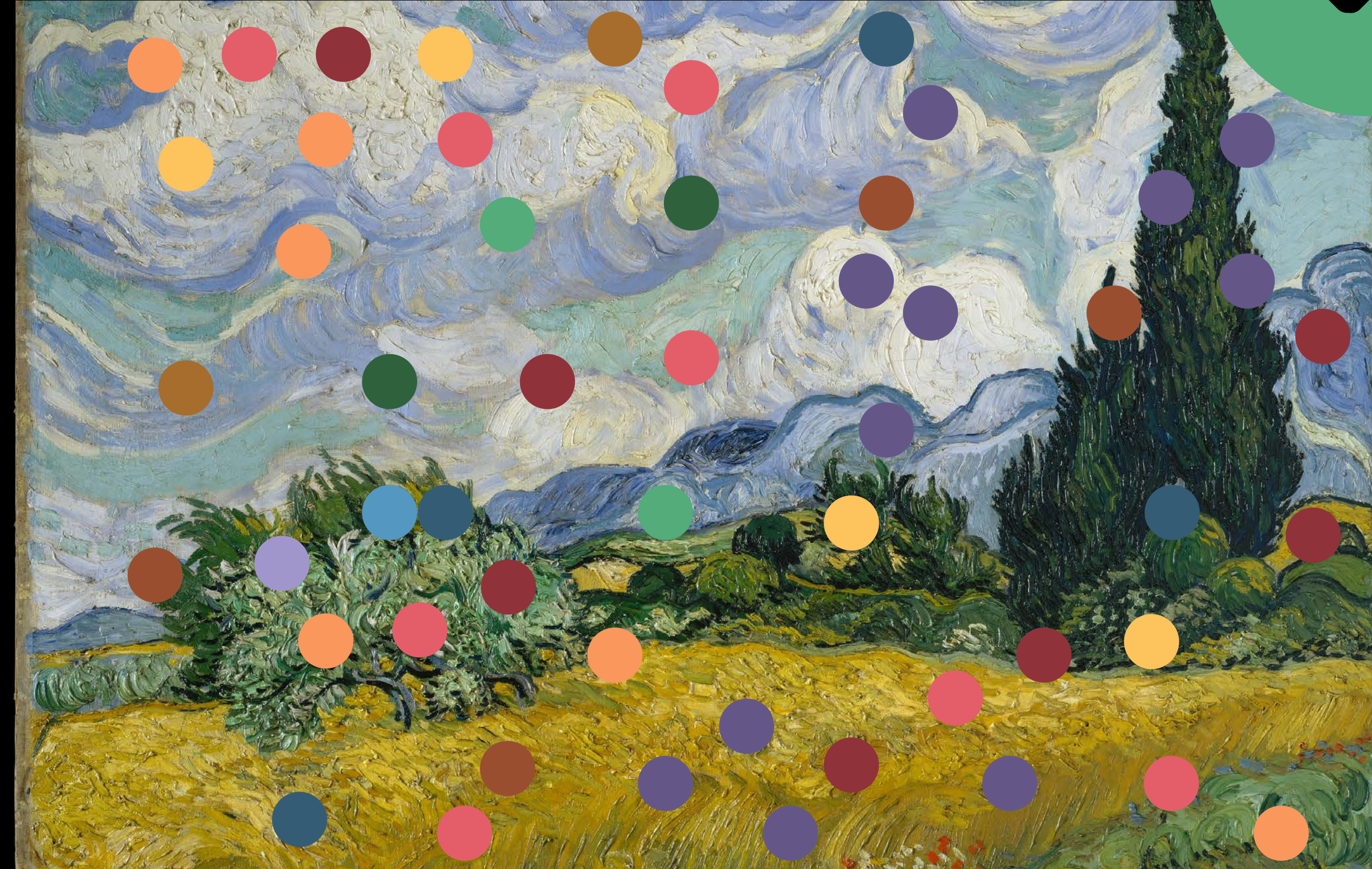
Good Images to Track

High texture

High local contrast

Well distributed histogram

No repetitive structures



Reference Image Quality in Xcode

Each image is analyzed

AR Resource Group

AR Resource Group

AR Reference Image

Name:

Size:
Width Height

Units:

Bahamas Aerial

Color Burst 3

Elephant

Lake

Lion

Poppies

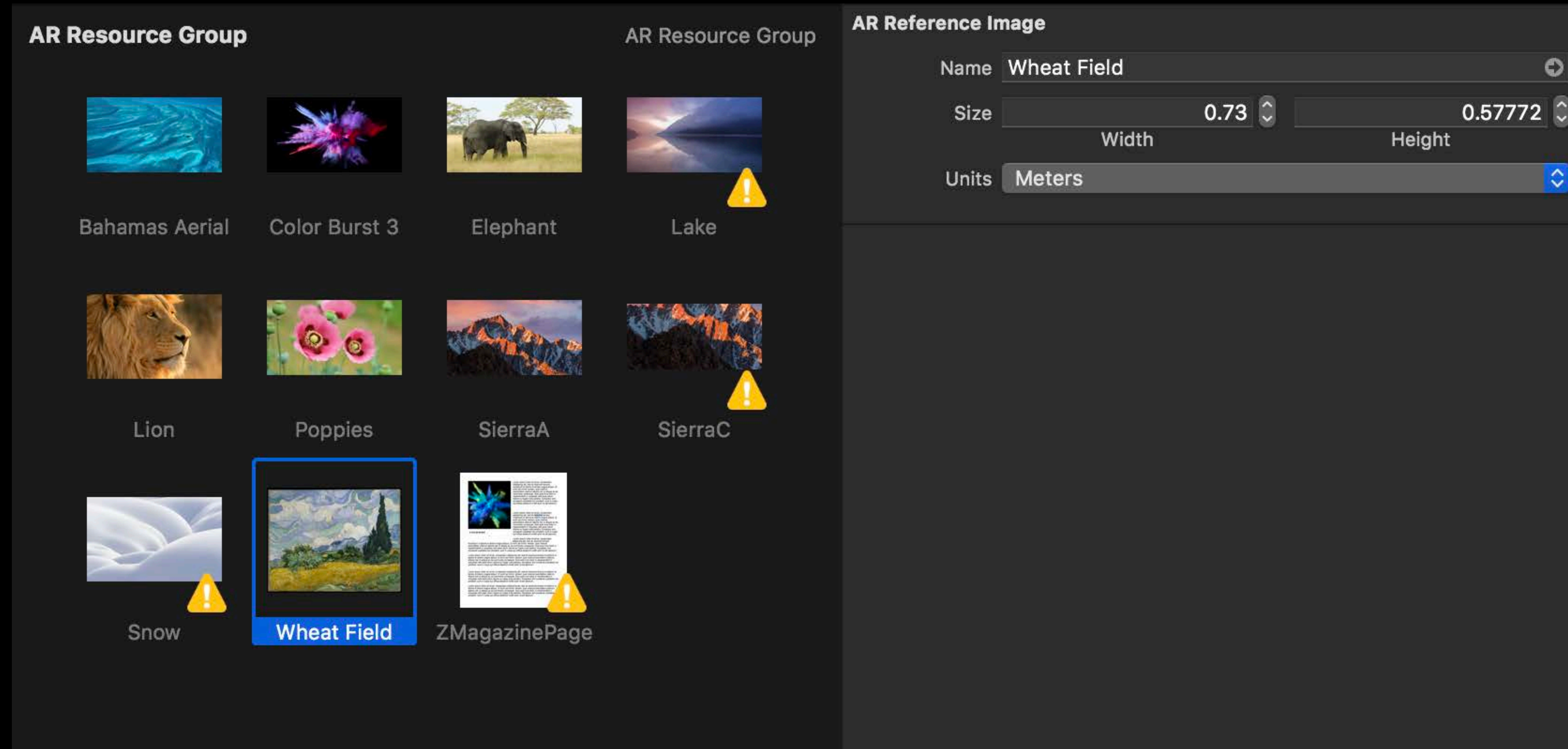
SierraA

SierraC

Snow

Wheat Field

ZMagazinePage



Reference Image Quality in Xcode

Each image is analyzed

The screenshot displays the Xcode interface for managing AR Reference Images. On the left, a grid of 12 images is shown, each with a label and a warning icon. The images are: Bahamas Aerial, Color Burst 3, Elephant, Lake, Lion, Poppies, SierraA, SierraC, Snow, Wheat Field, and ZMagazinePage. The ZMagazinePage image is highlighted with a blue border. On the right, the 'AR Reference Image' inspector is open, showing the name 'ZMagazinePage', size (Width: 0.18, Height: 0.22389), and units (Meters). A callout box with a warning icon and text explains the quality issues with the ZMagazinePage image.

AR Resource Group

AR Reference Image

Name: ZMagazinePage

Size: Width 0.18, Height 0.22389

Units: Meters

- **AR reference image "ZMagazinePage":** The histogram of the image is narrow or not well distributed. Recognition works better on images with wider, flatter histograms.
- **AR reference image "ZMagazinePage":** The image has repetitive structures. Recognition works better on images without repetitive structures.

Reference Image Quality in Xcode

Similar images

The screenshot displays the Xcode interface for configuring AR Reference Images. On the left, a grid of AR Resource Groups is shown, each with a thumbnail and a name. The 'SierraC' resource is highlighted with a blue border and a yellow warning icon. On the right, the 'AR Reference Image' settings panel is visible, showing the name 'SierraC', a size of 1 by 0.49159 meters, and units set to 'Meters'. A callout box with a yellow warning icon points to the 'SierraC' resource, displaying the message: 'AR reference image "SierraC" is too similar to "SierraA".'

AR Resource Group

- Bahamas Aerial
- Color Burst 3
- Elephant
- Lake
- Lion
- Poppies
- SierraA
- SierraC
- Snow
- Wheat Field
- ZMagazinePage

AR Reference Image

Name: SierraC

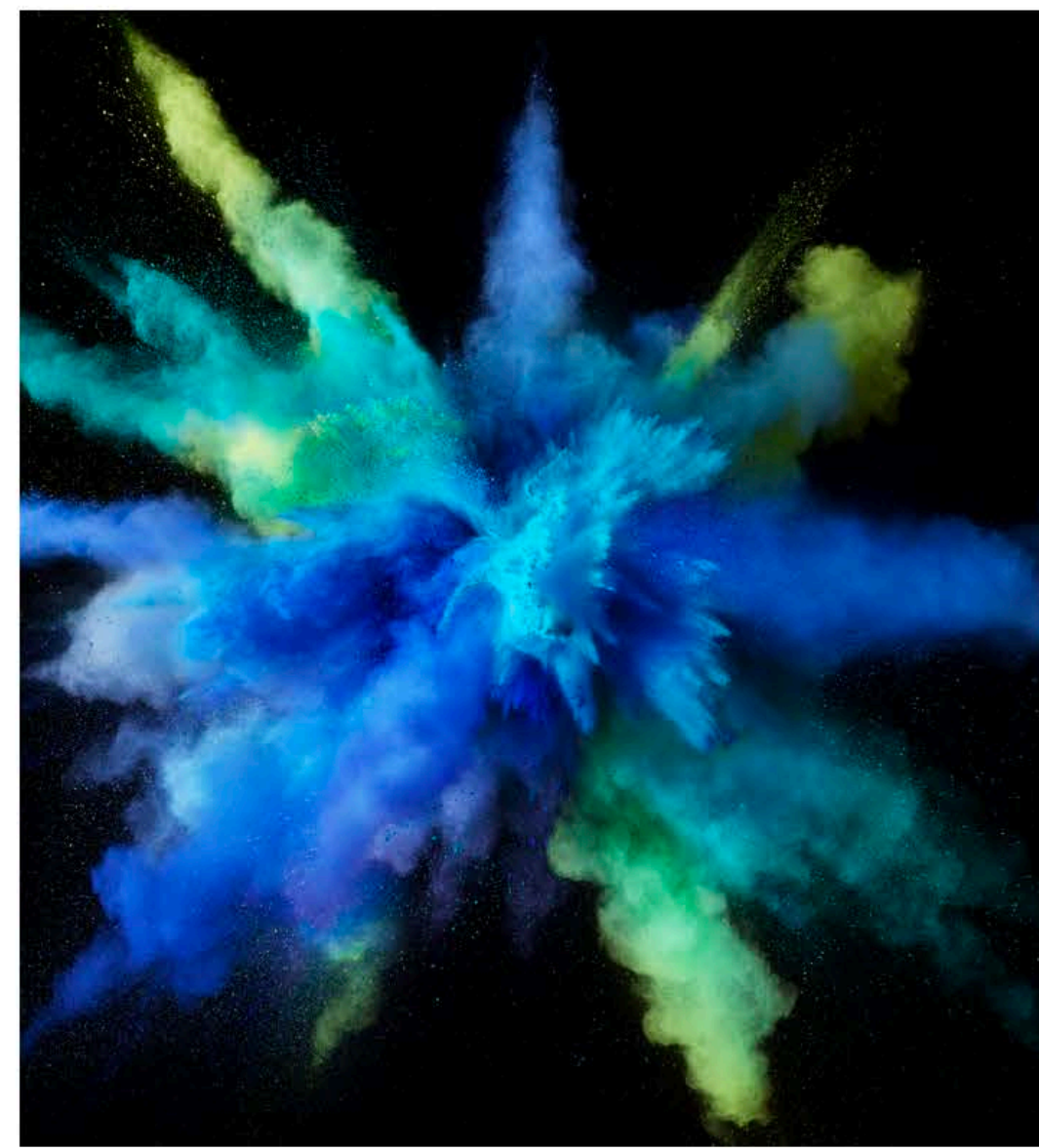
Size: Width 1, Height 0.49159

Units: Meters

AR reference image "SierraC" is too similar to "SierraA".

Reference Image Quality—Tips

Crop image to its core content



A COLOR BURST

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

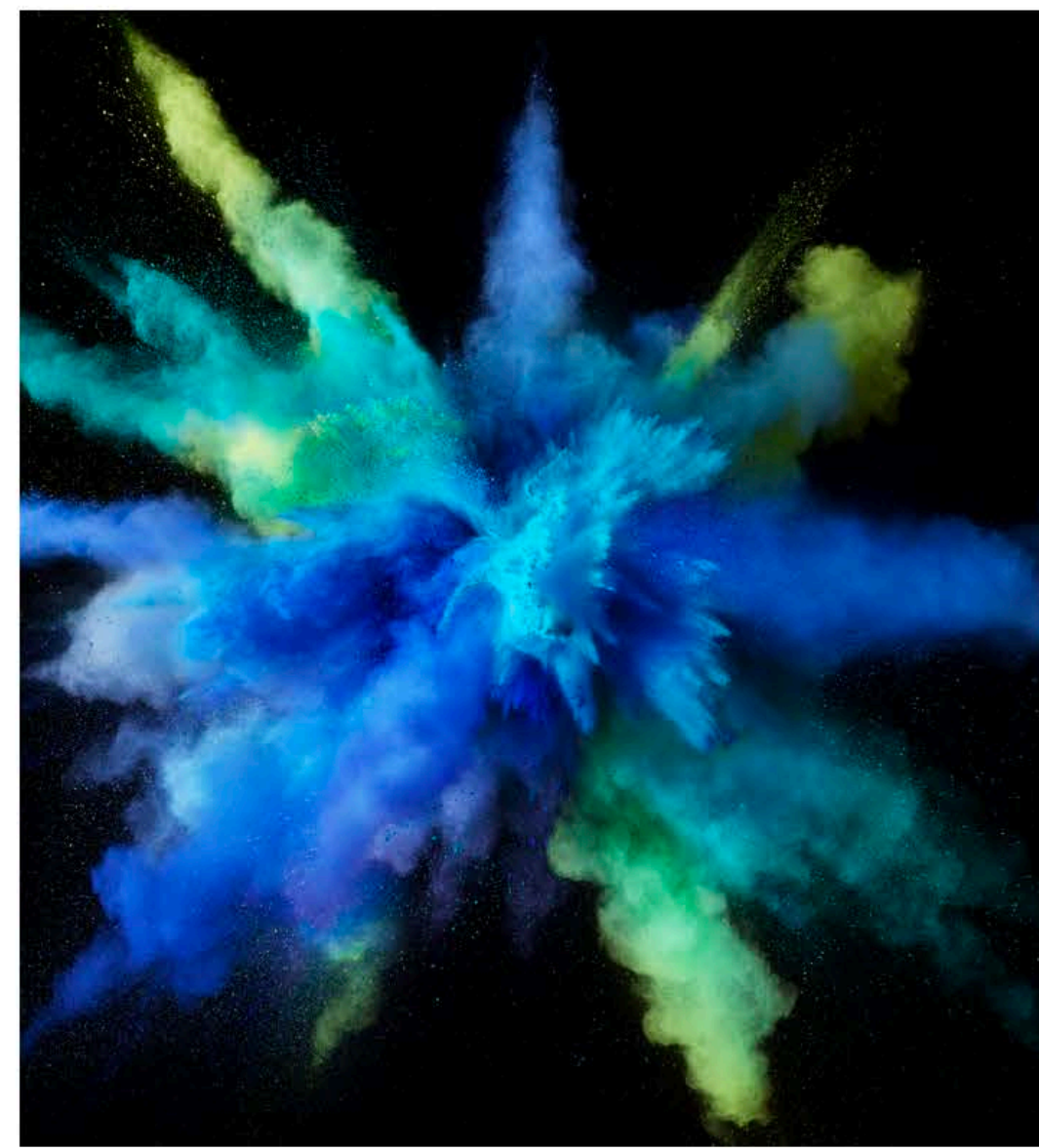
Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.



Reference Image Quality—Tips

Crop image to its core content



A COLOR BURST

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

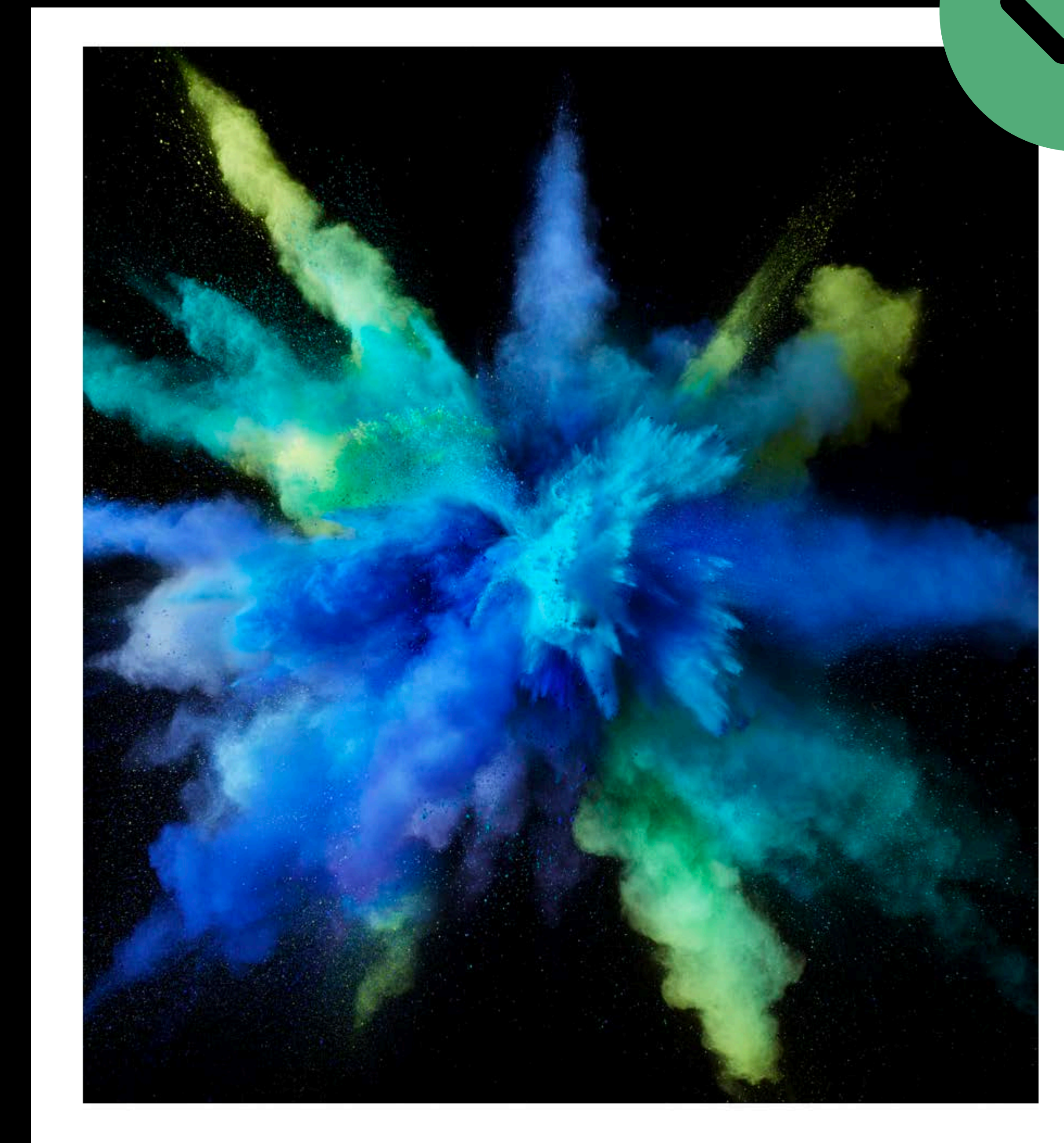
Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

incidunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

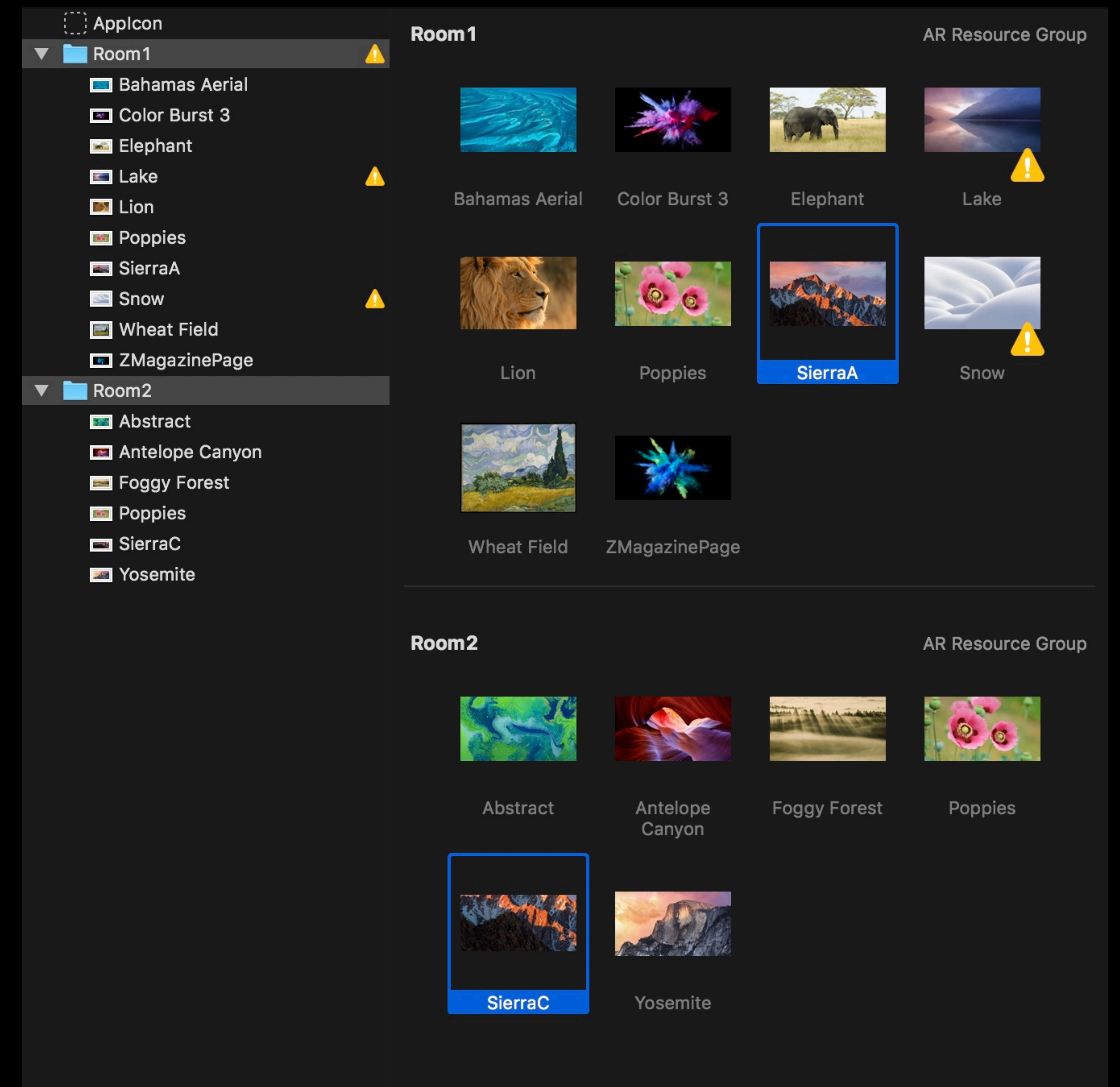
Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.



Reference Image Quality—Tips

Use multiple AR Resource Groups

Allow many more images to be detected

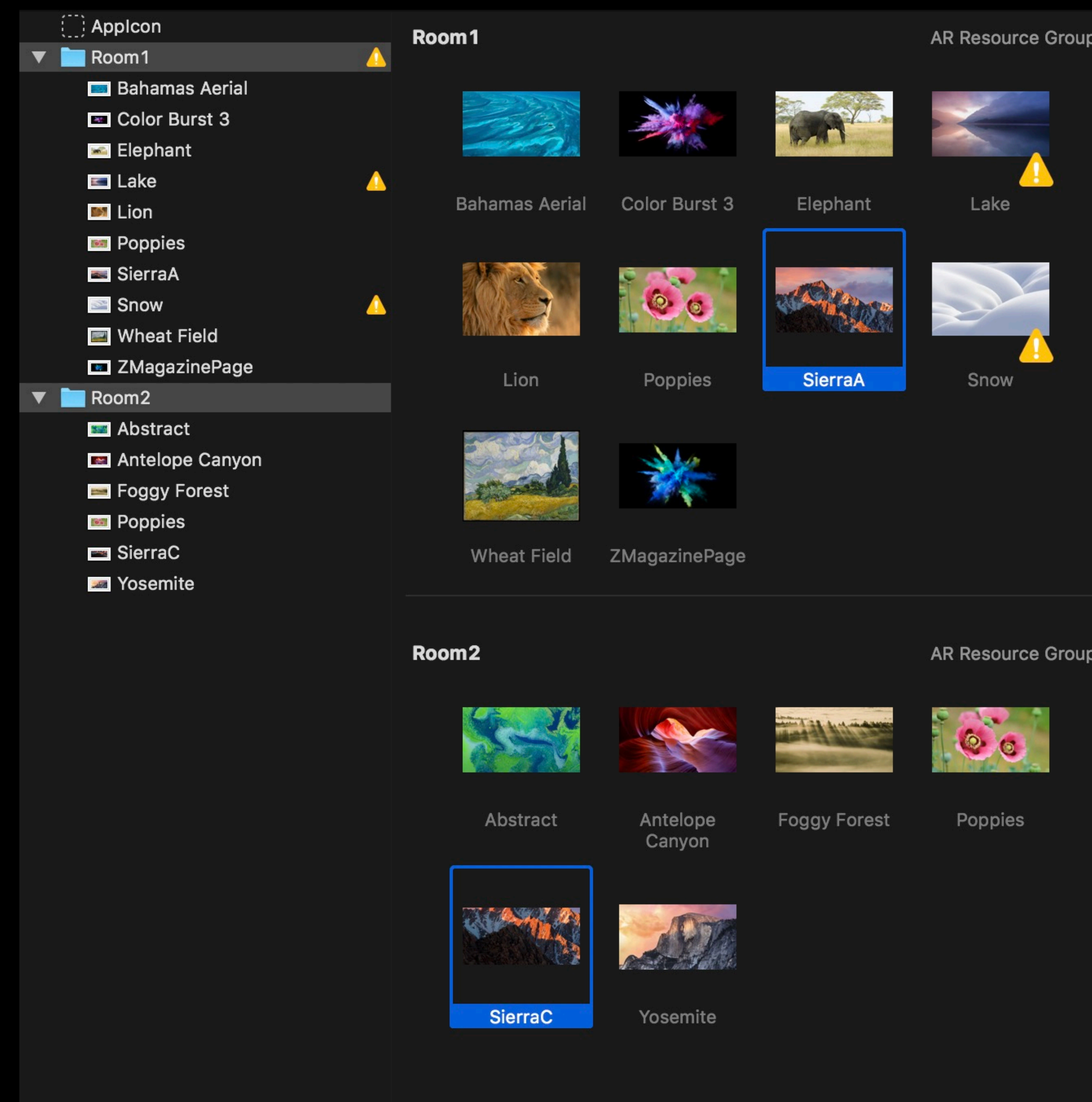


Reference Image Quality—Tips

Use multiple AR Resource Groups

Allow many more images to be detected

Max 25 images per group recommended



Reference Image Quality—Tips

Use multiple AR Resource Groups

Allow many more images to be detected

Max 25 images per group recommended

Switch between groups programmatically

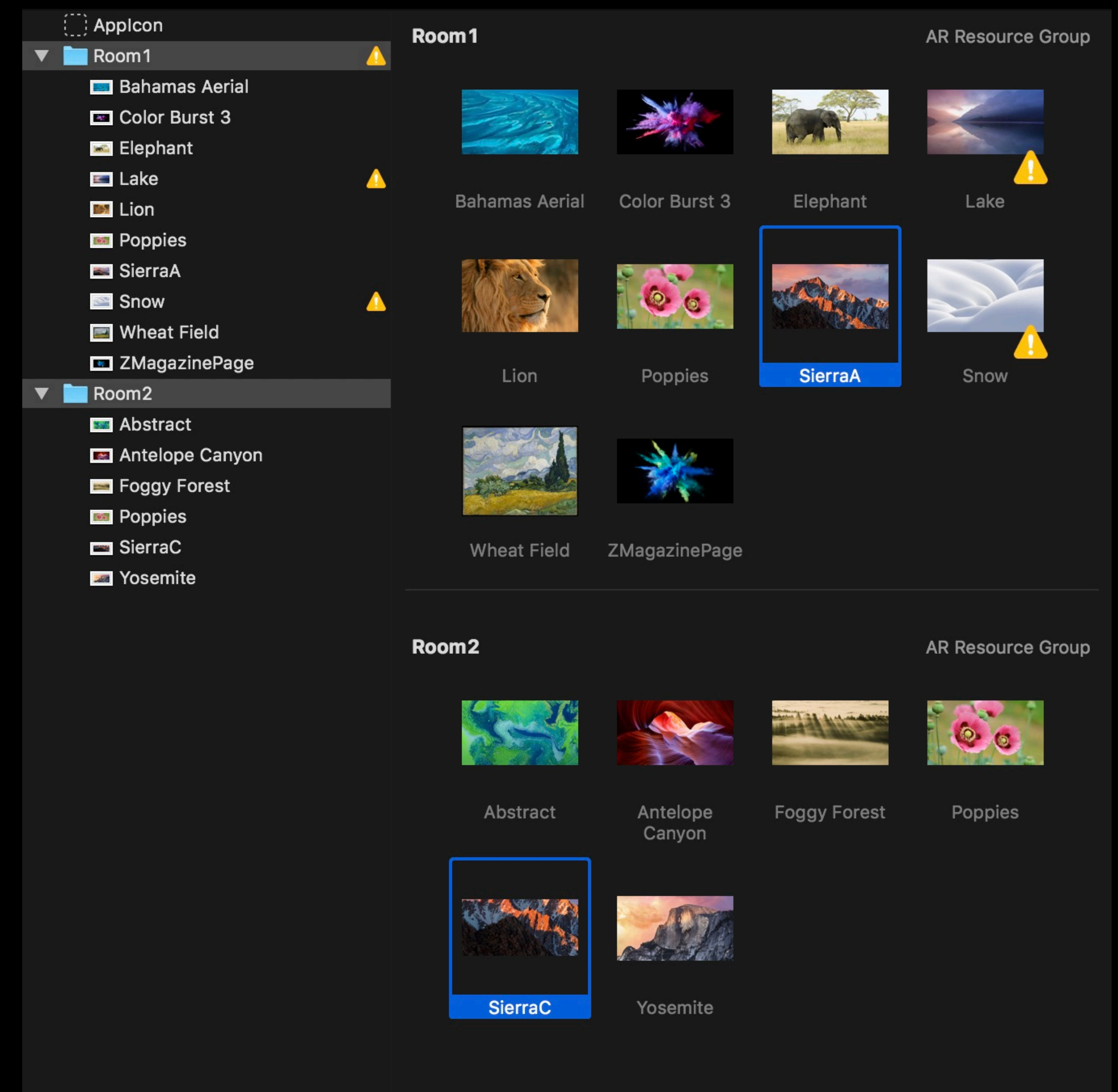


Image Tracking Configurations



ARImageTrackingConfiguration



ARWorldTrackingConfiguration

Image Tracking Configurations



`ARImageTrackingConfiguration`

Standalone image tracking



`ARWorldTrackingConfiguration`

Image Tracking Configurations



`ARImageTrackingConfiguration`

Standalone image tracking

No world origin



`ARWorldTrackingConfiguration`

Image Tracking Configurations



`ARImageTrackingConfiguration`

Standalone image tracking

No world origin



`ARWorldTrackingConfiguration`

Image and World tracking

Image Tracking Configurations



`ARImageTrackingConfiguration`

Standalone image tracking

No world origin



`ARWorldTrackingConfiguration`

Image and World tracking

Scene understanding available

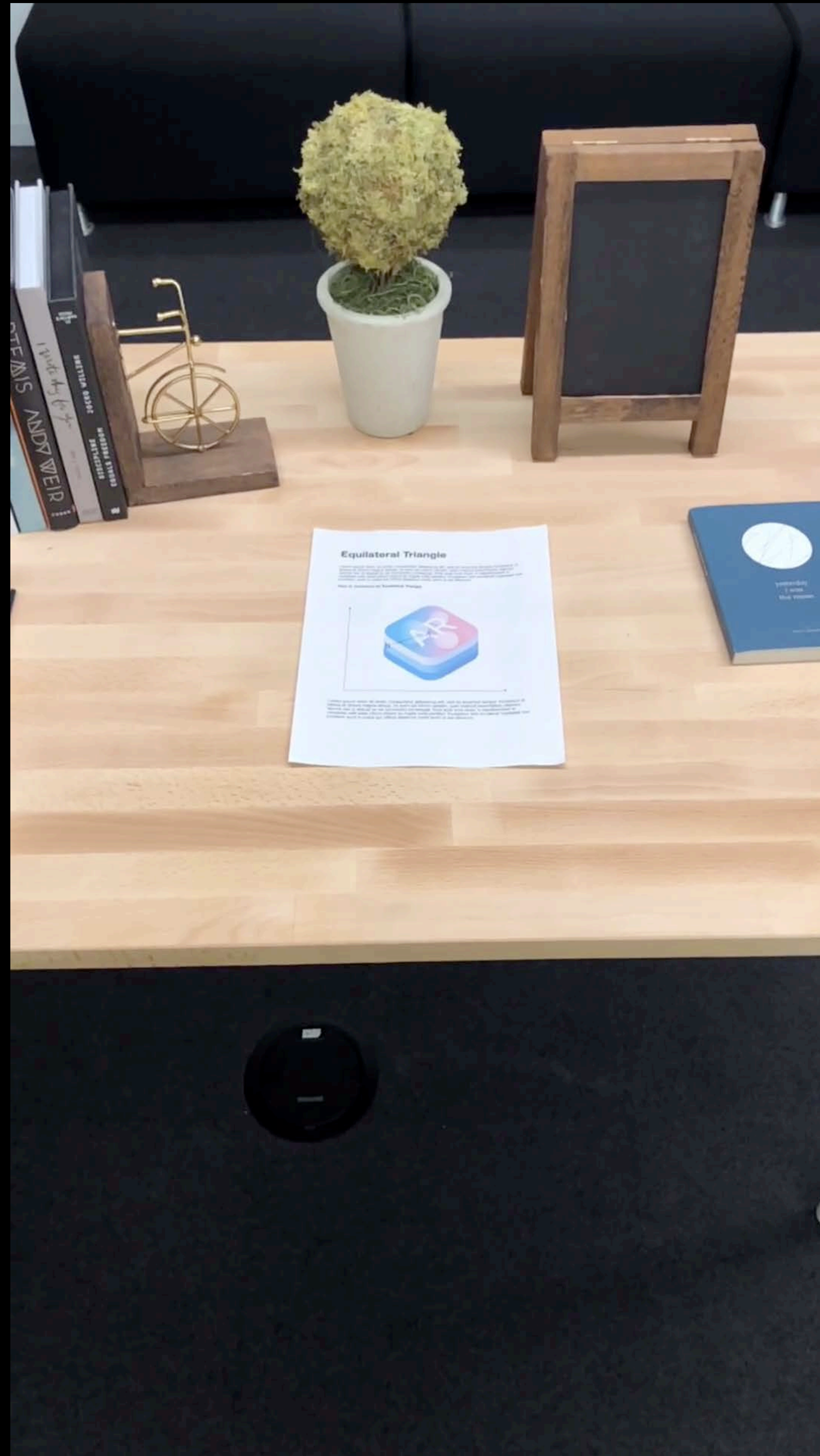
Image Tracking Configurations

ARImageTrackingConfiguration

ARWorldTrackingConfiguration

Image Tracking Configurations

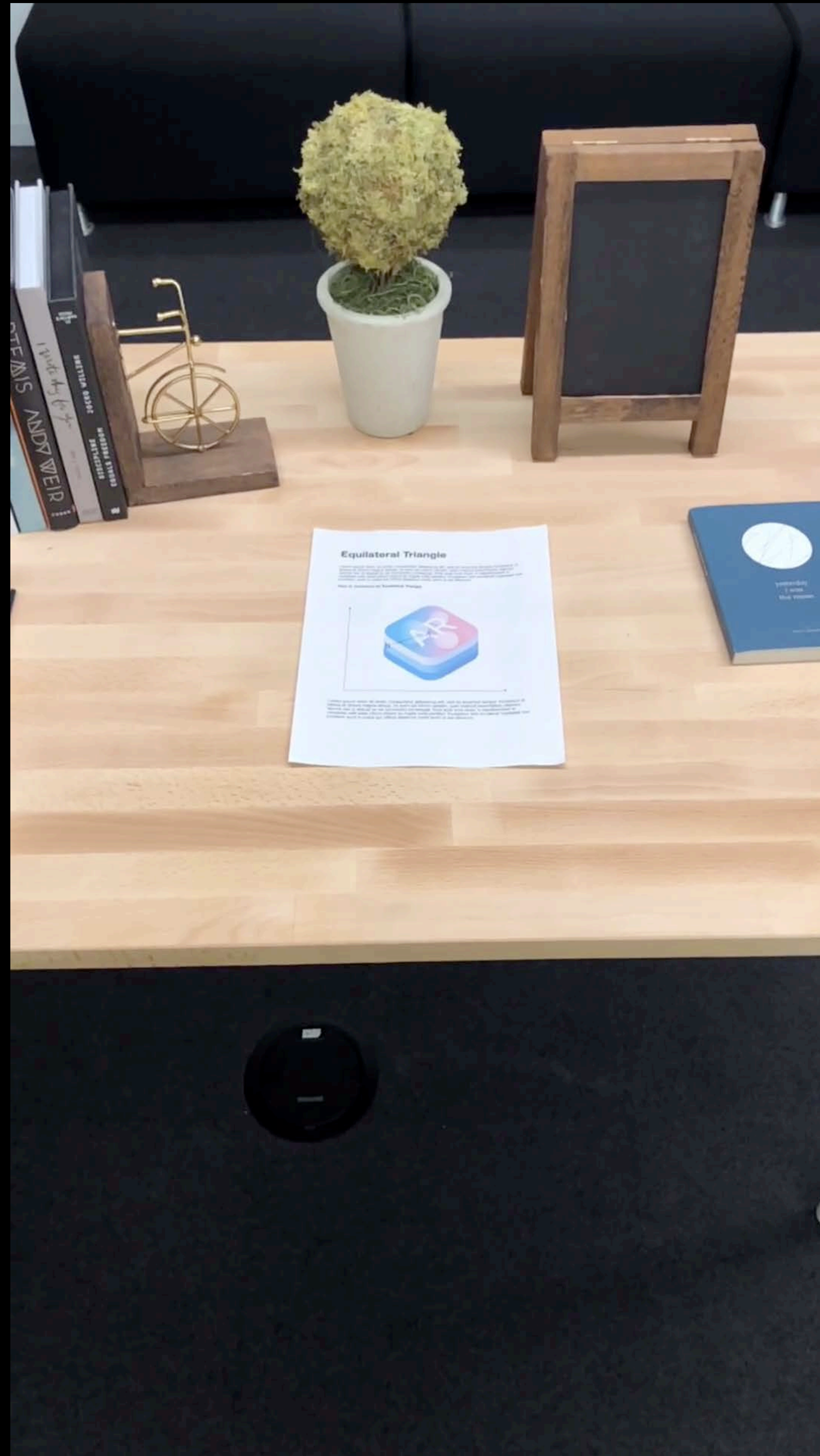
ARImageTrackingConfiguration



ARWorldTrackingConfiguration

Image Tracking Configurations

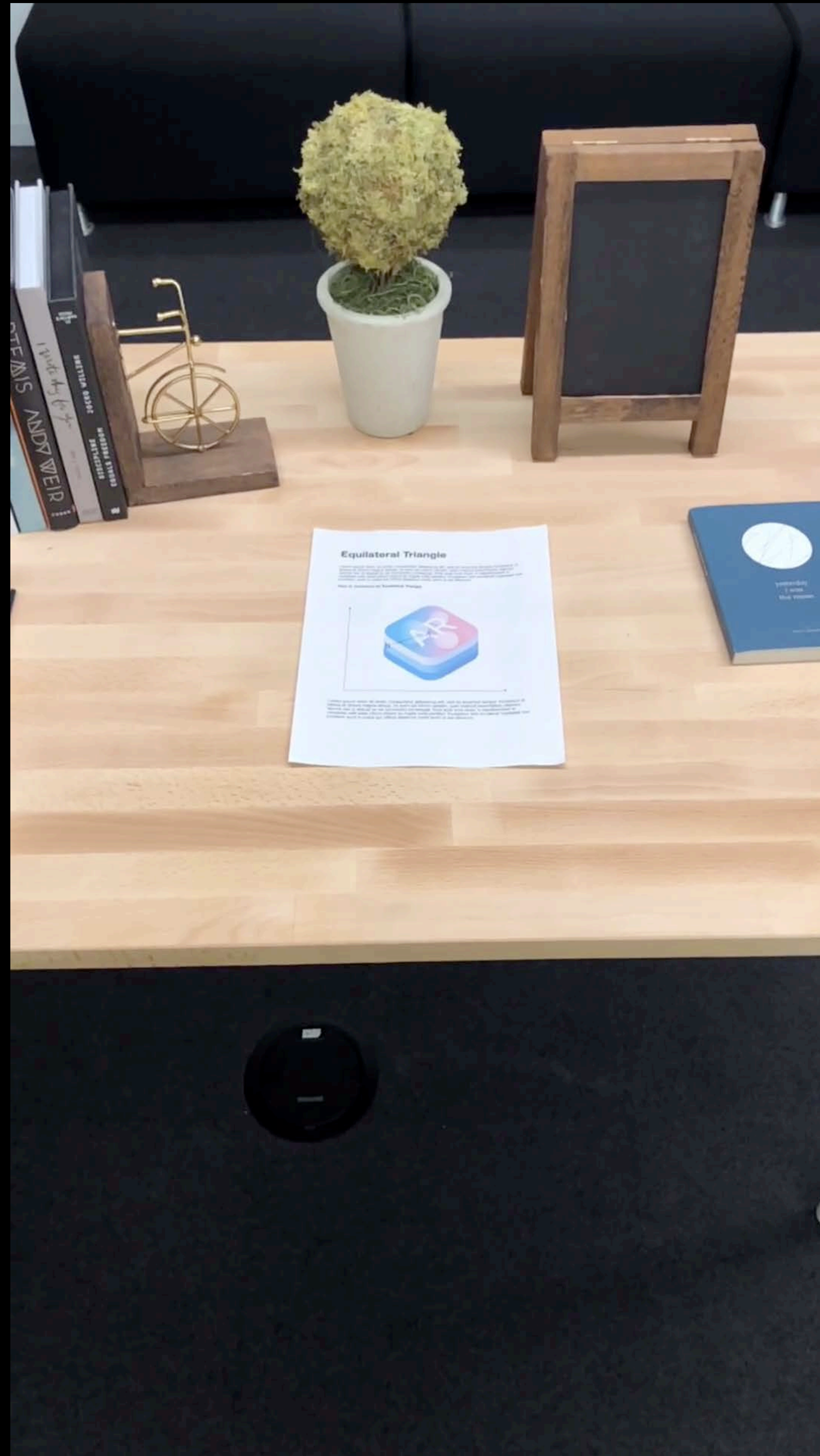
ARImageTrackingConfiguration



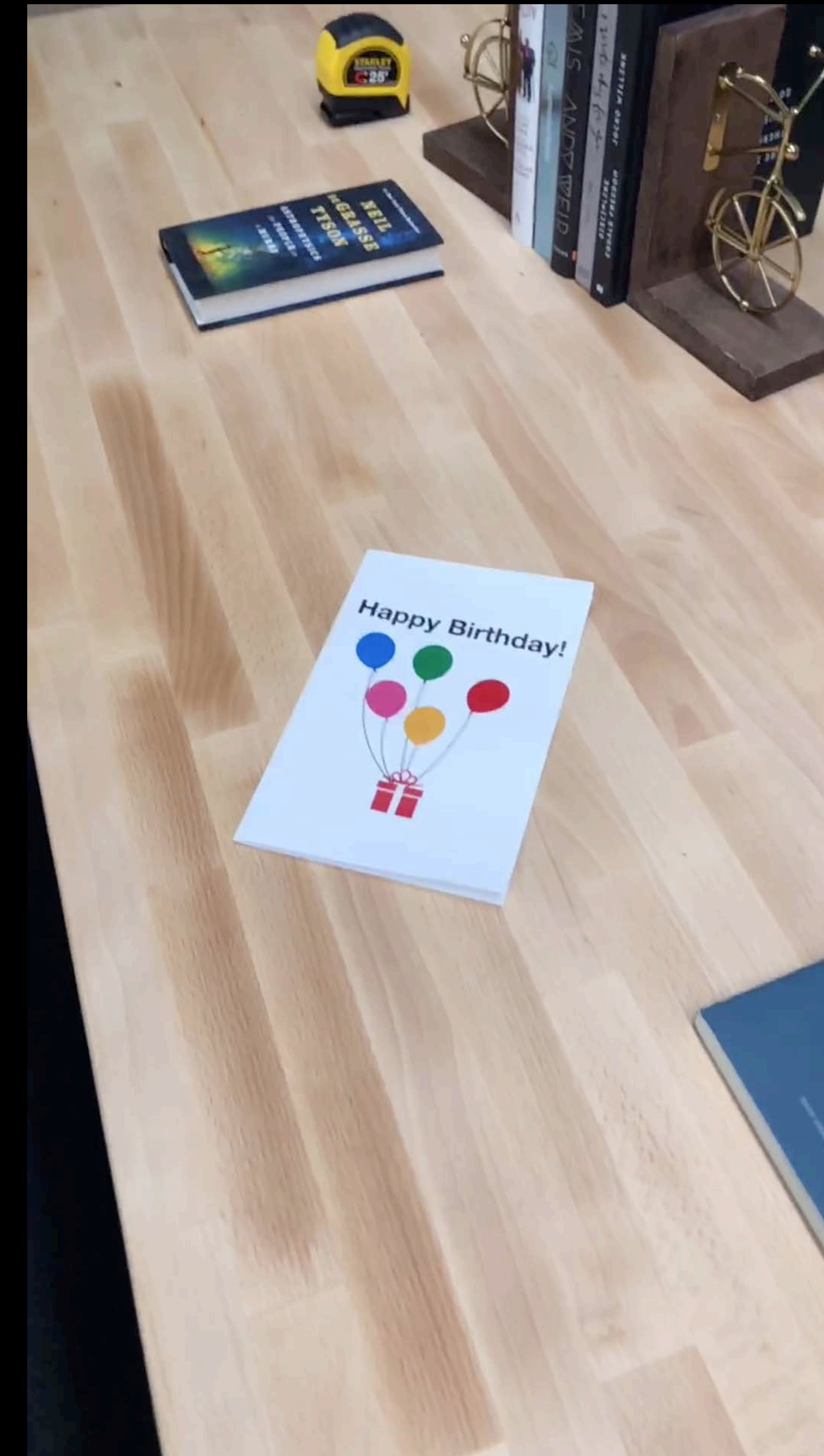
ARWorldTrackingConfiguration

Image Tracking Configurations

ARImageTrackingConfiguration



ARWorldTrackingConfiguration




```
// Load Images from Assets
let imageSet = ARReferenceImage.referenceImages(inGroupNamed: "Room1", bundle: Bundle.main)
guard let imageSet = imageSet else {
    print("Error loading images")
    return
}

// Create a session configuration
let configuration = ARImageTrackingConfiguration()
configuration.trackingImages = imageSet

// Run the session
let session = ARSession()
session.run(configuration)
```



```
// Load Images from Assets
let imageSet = ARReferenceImage.referenceImages(inGroupNamed: "Room1", bundle: Bundle.main)
guard let imageSet = imageSet else {
    print("Error loading images")
    return
}
```

```
// Create a session configuration
let configuration = ARImageTrackingConfiguration()
configuration.trackingImages = imageSet
```

```
// Run the session
let session = ARSession()
session.run(configuration)
```



```
// Load Images from Assets
let imageSet = ARReferenceImage.referenceImages(inGroupNamed: "Room1", bundle: Bundle.main)
guard let imageSet = imageSet else {
    print("Error loading images")
    return
}
```

```
// Create a session configuration
let configuration = ARImageTrackingConfiguration()
configuration.trackingImages = imageSet
```

```
// Run the session
let session = ARSession()
session.run(configuration)
```



```
// Load Images from Assets
let imageSet = ARReferenceImage.referenceImages(inGroupNamed: "Room1", bundle: Bundle.main)
guard let imageSet = imageSet else {
    print("Error loading images")
    return
}

// Create a session configuration
let configuration = ARImageTrackingConfiguration()
configuration.trackingImages = imageSet

// Run the session
let session = ARSession()
session.run(configuration)
```


Getting Results

```
func session(_ session: ARSession, didUpdate anchors: [ARAnchor]) {  
    for anchor in anchors {  
        if let imageAnchor = anchor as? ARImageAnchor {...}  
    }  
}
```


Getting Results

```
func session(_ session: ARSession, didUpdate anchors: [ARAnchor]) {  
    for anchor in anchors {  
        if let imageAnchor = anchor as? ARImageAnchor {...}  
    }  
}
```

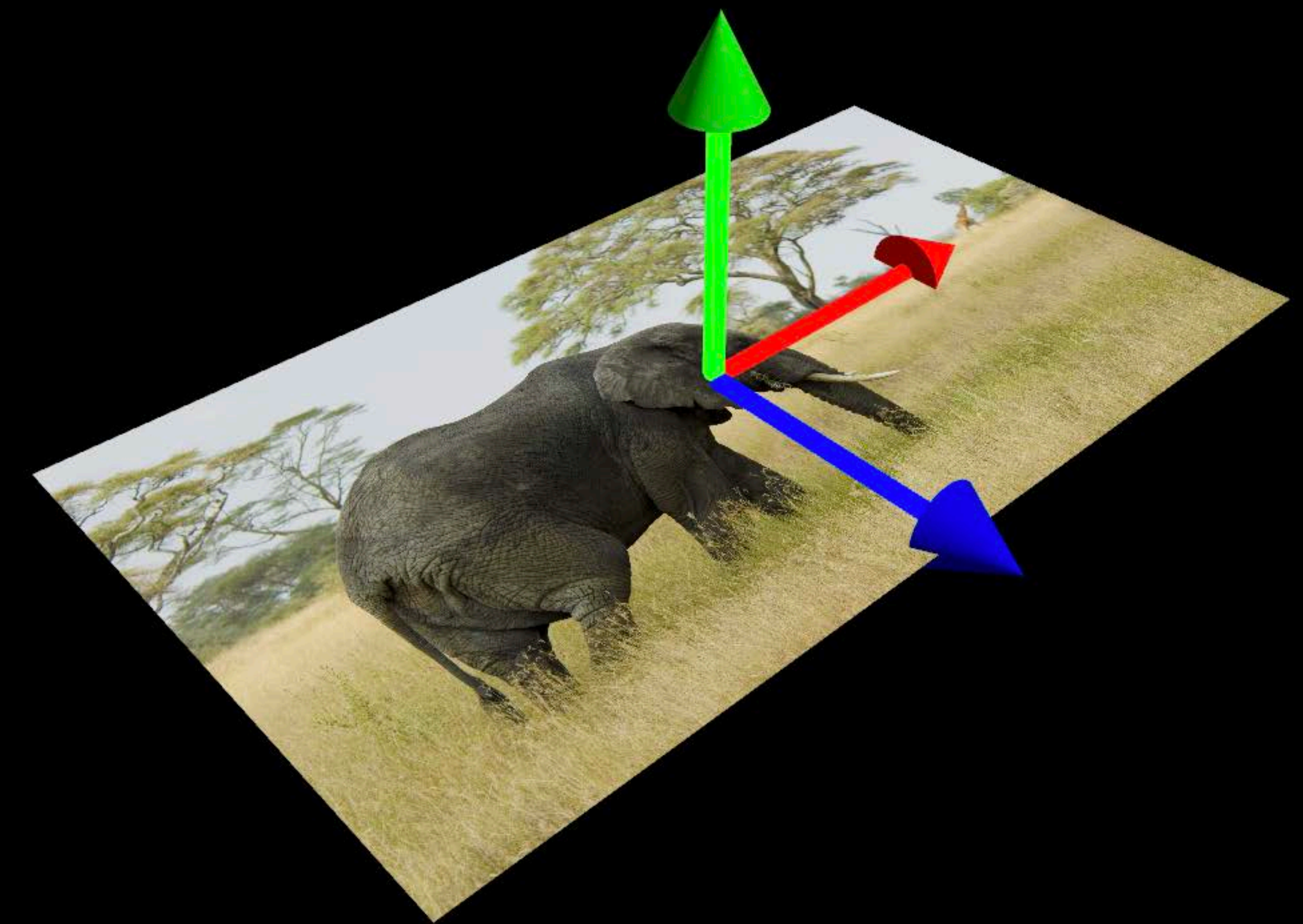

Getting Results

```
func session(_ session: ARSession, didUpdate anchors: [ARAnchor]) {  
    for anchor in anchors {  
        if let imageAnchor = anchor as? ARImageAnchor {...}  
    }  
}
```

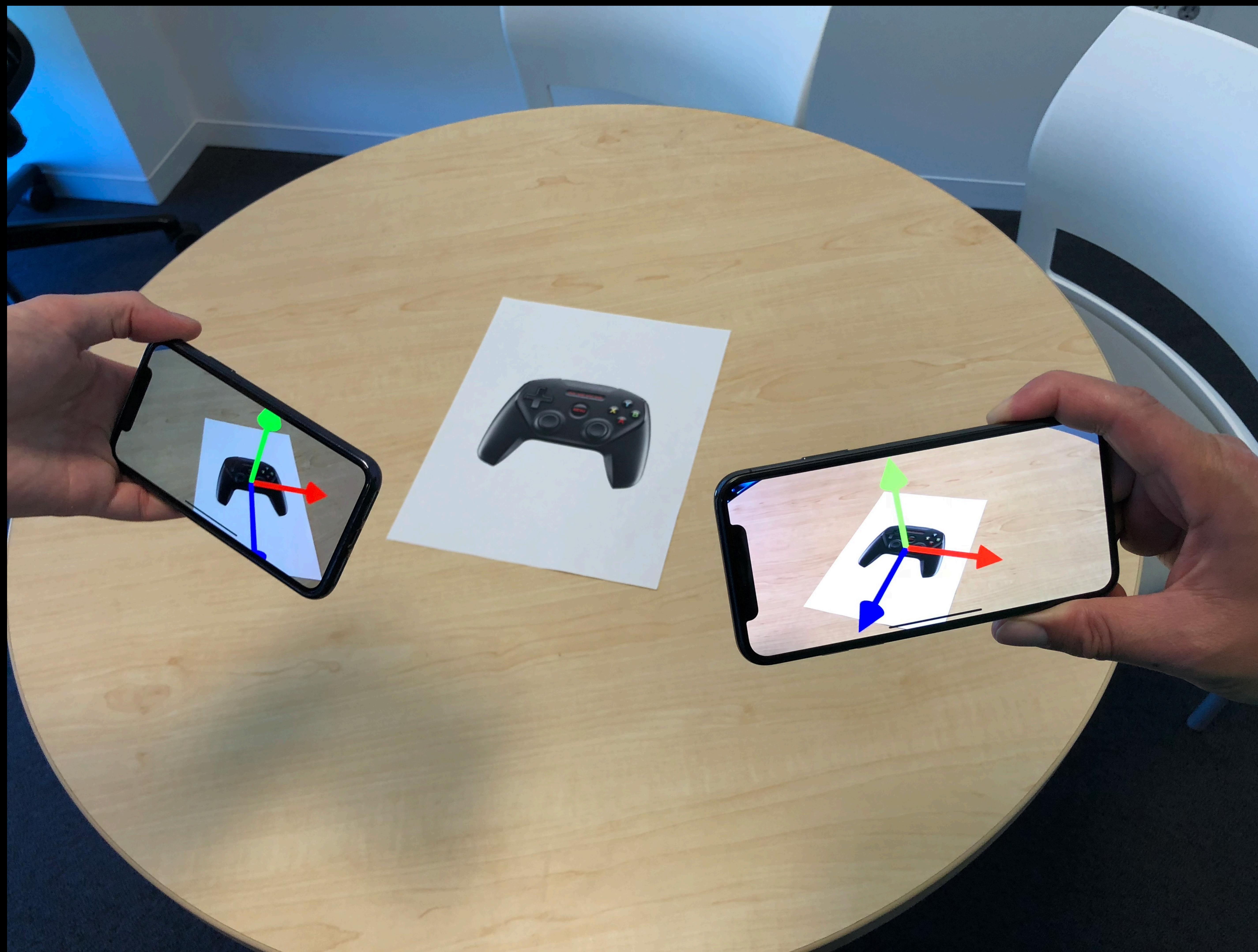

Getting Results

```
func session(_ session: ARSession, didUpdate anchors: [ARAnchor]) {  
    for anchor in anchors {  
        if let imageAnchor = anchor as? ARImageAnchor {...}  
    }  
}
```

```
open class ARImageAnchor : ARAnchor, ARTrackable {  
    open var transform: simd_float4x4 { get }  
    open var referenceImage: ARReferenceImage { get }  
    public var isTracked: Bool { get }  
}
```



Absolute Coordinate Space for Shared Experiences



Absolute Coordinate Space at Precise Location



Object Detection





Object Detection



Scanning



Detection



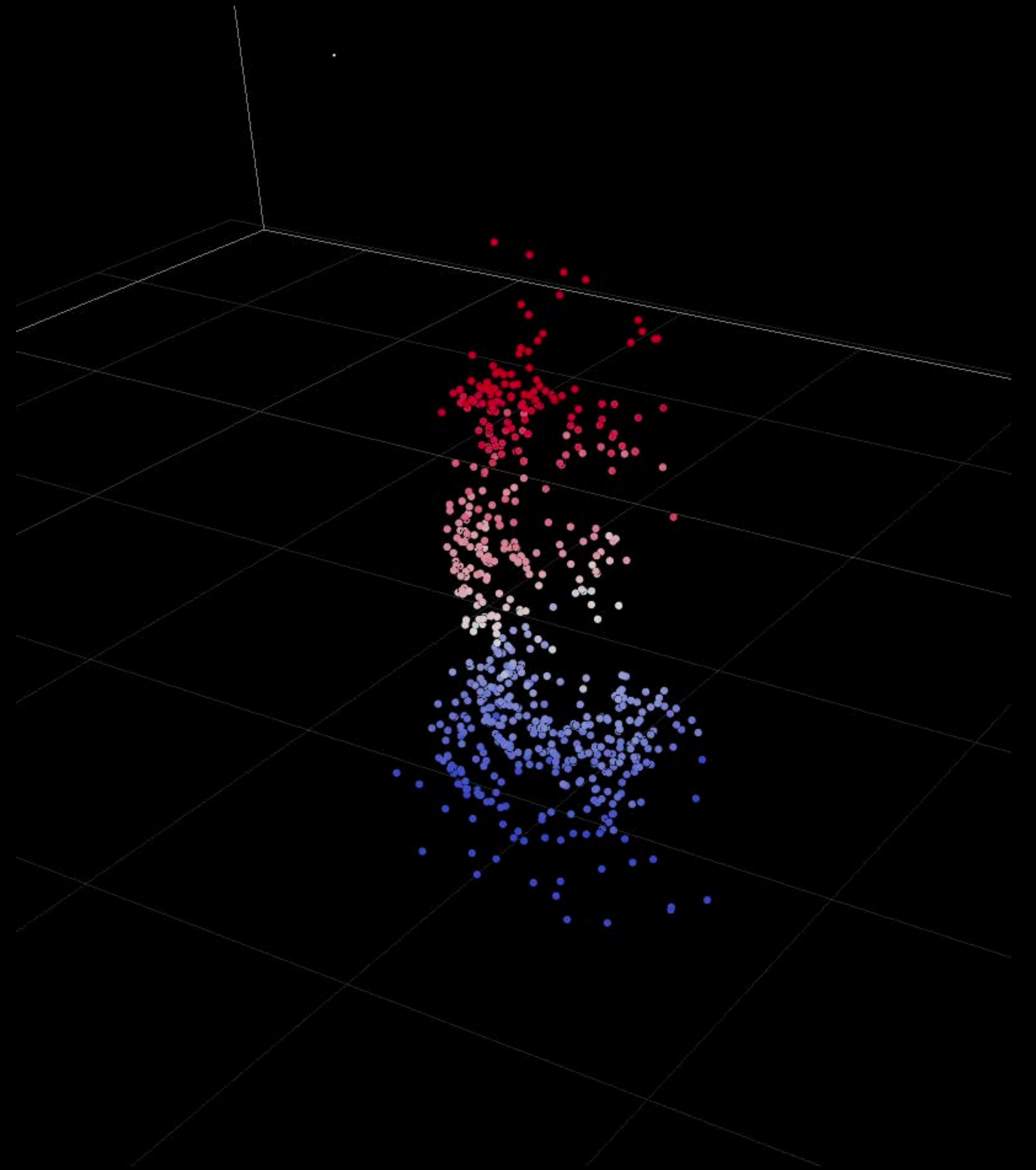
Scanning



Detection

How to Acquire an Object?

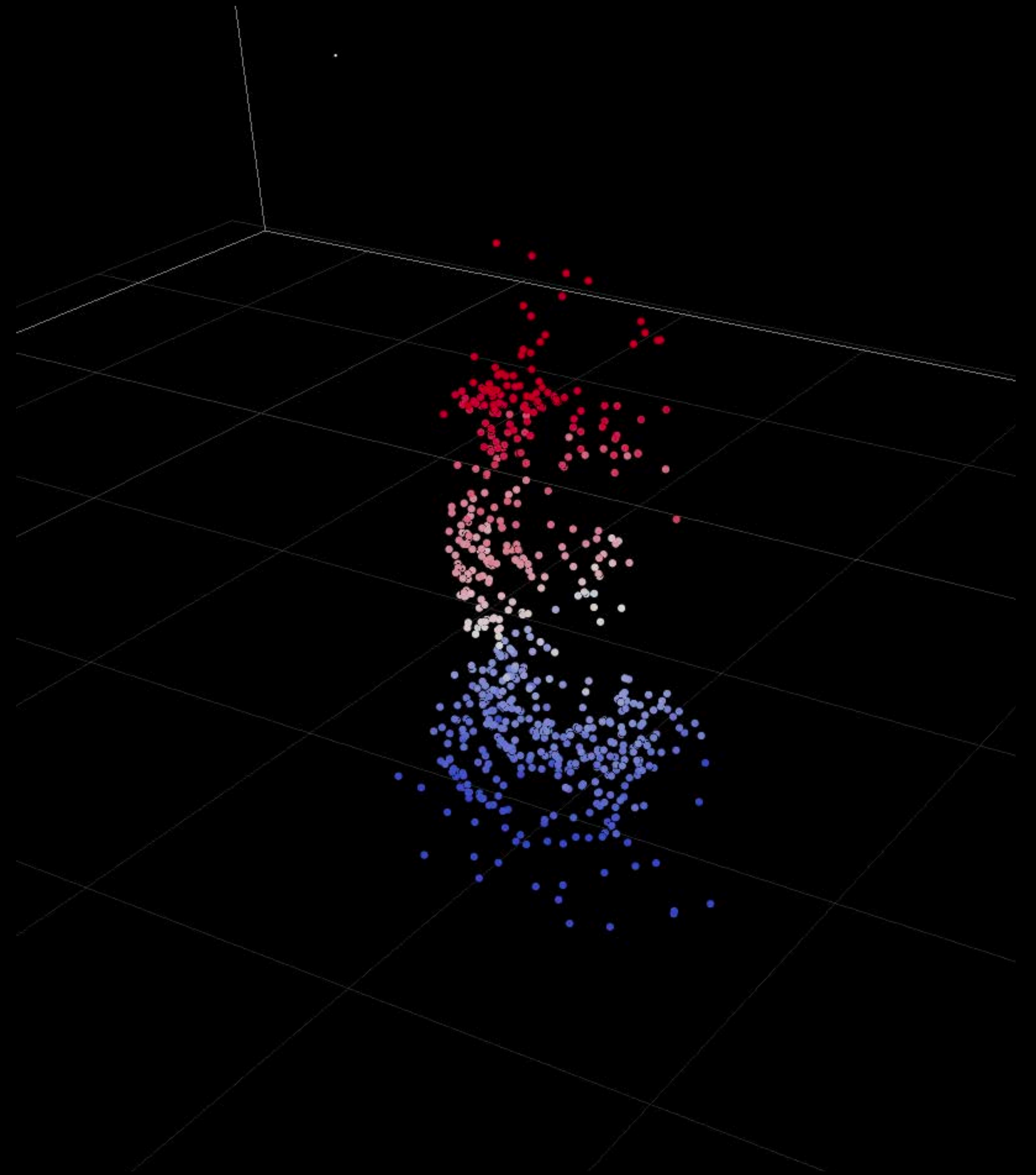
Similar representation as a world map



How to Acquire an Object?

Similar representation as a world map

Use "Scanning and Detecting 3D Objects"

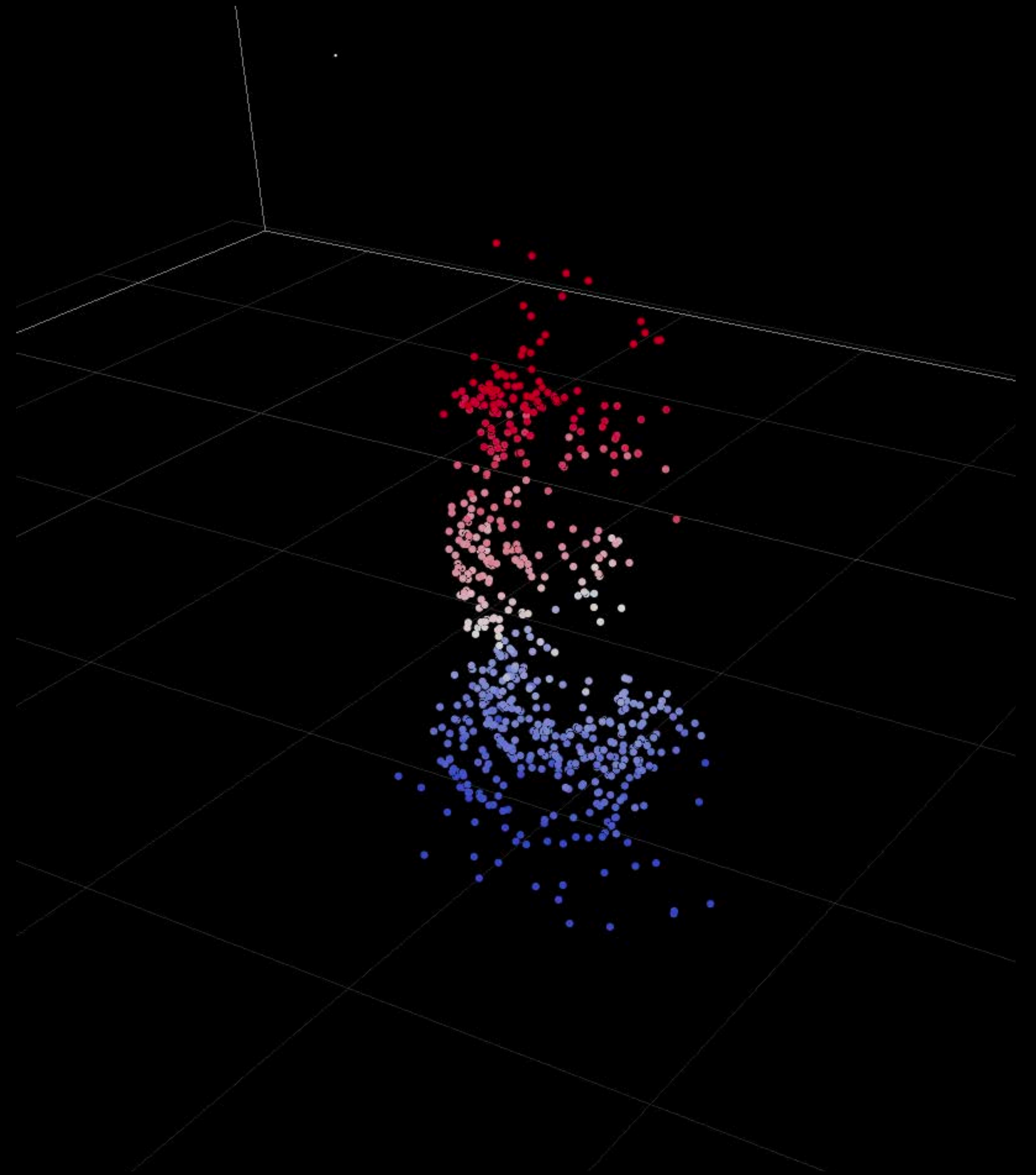


How to Acquire an Object?

Similar representation as a world map

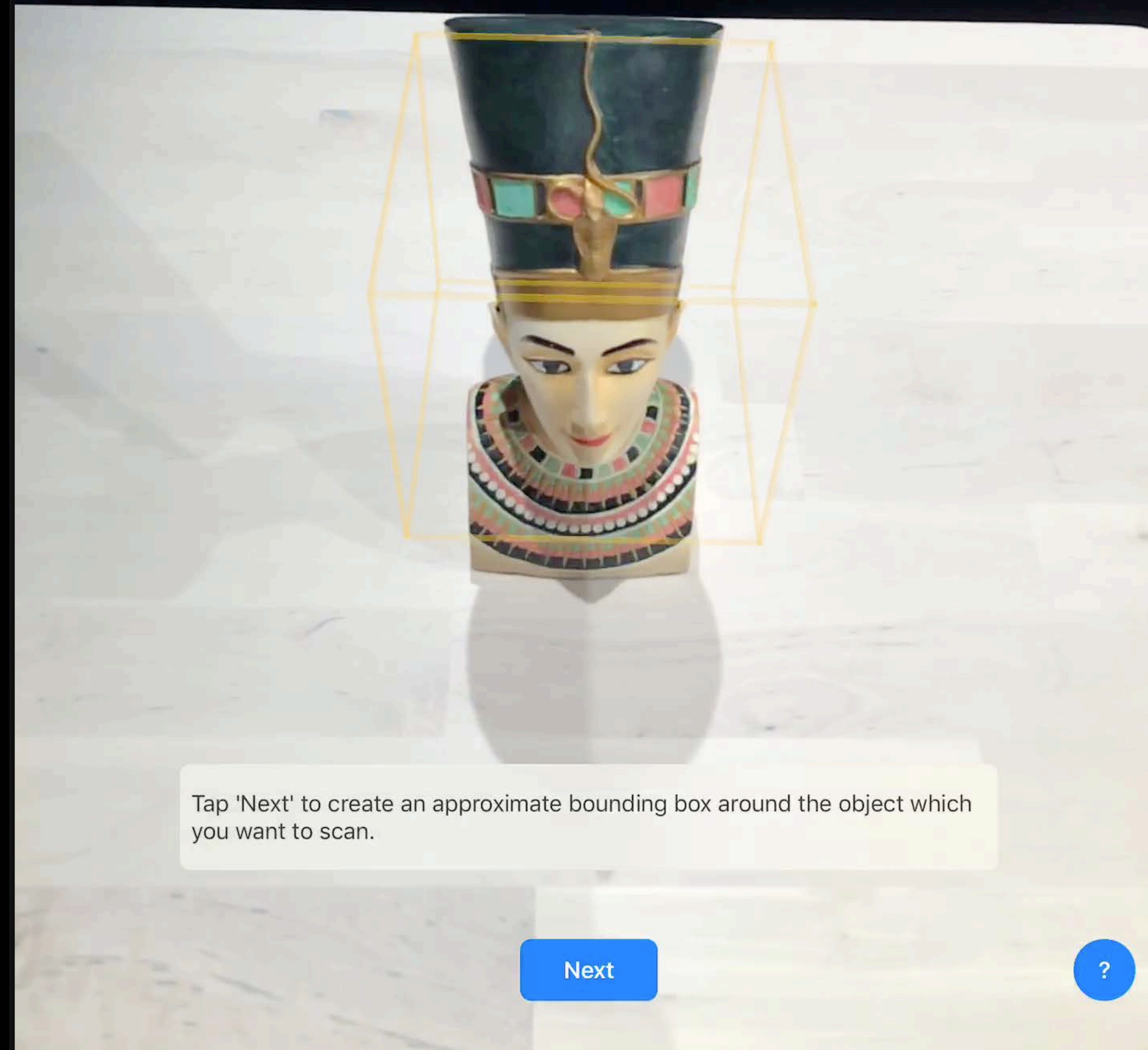
Use "Scanning and Detecting 3D Objects"

Detection Quality affected by
Scanning Quality



Ready to scan

[Restart](#)



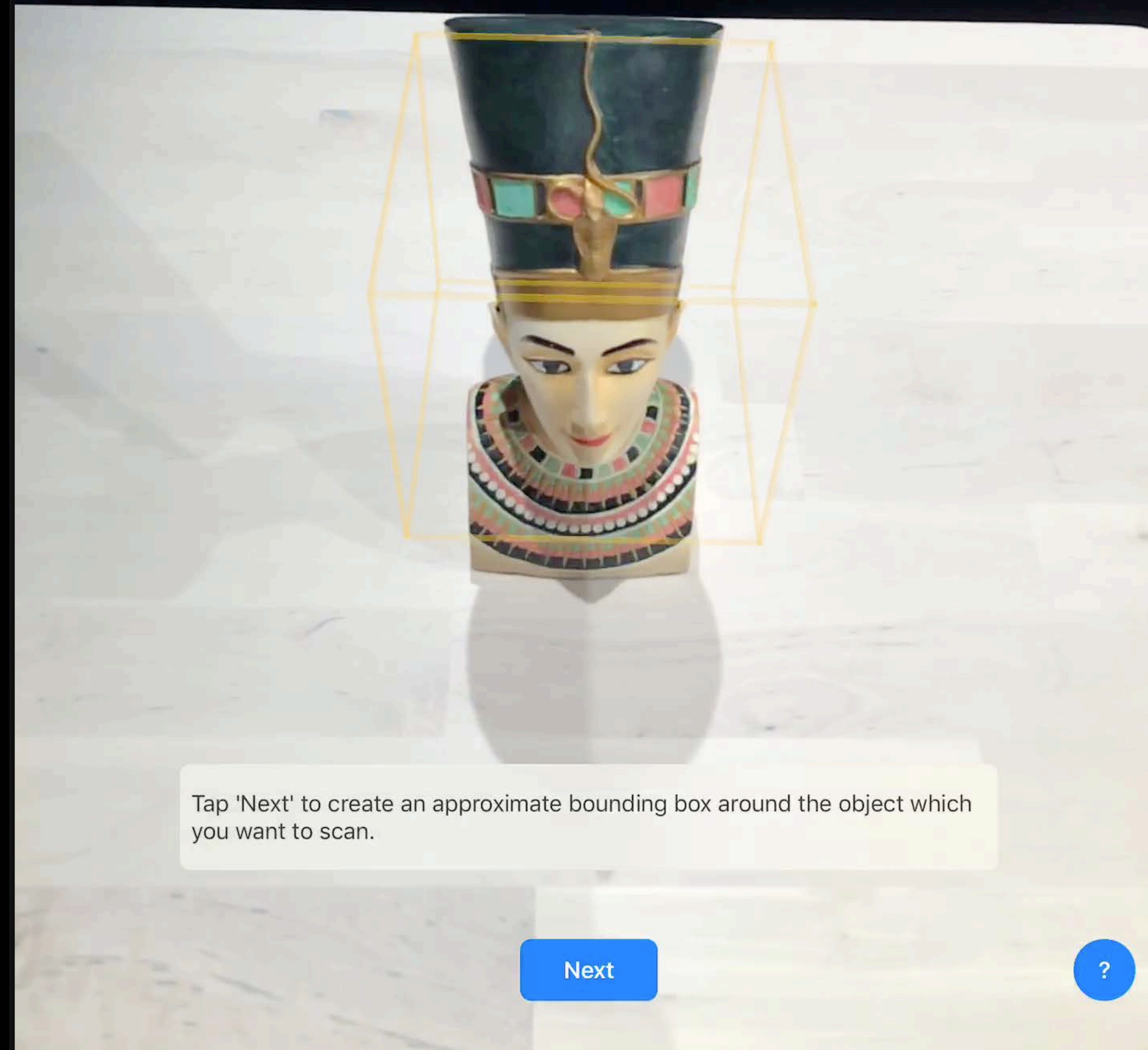
Tap 'Next' to create an approximate bounding box around the object which you want to scan.

Next

?

Ready to scan

[Restart](#)



Tap 'Next' to create an approximate bounding box around the object which you want to scan.

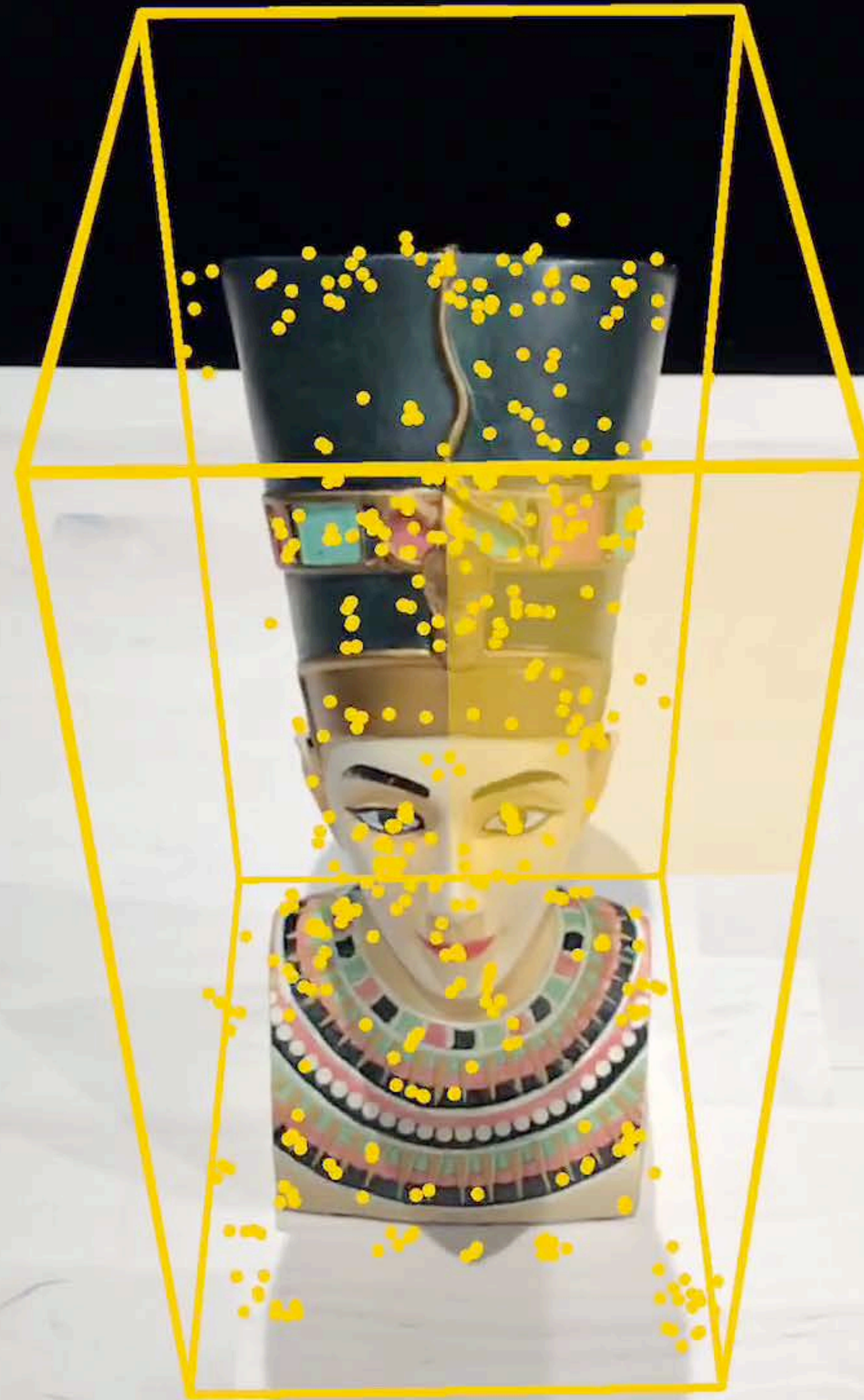
Next

?

Back

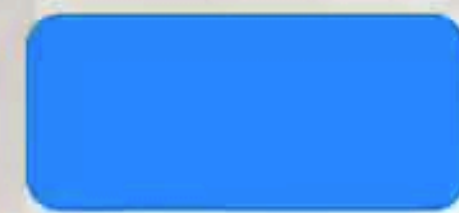
Scan (0%)

Restart



Scan the object

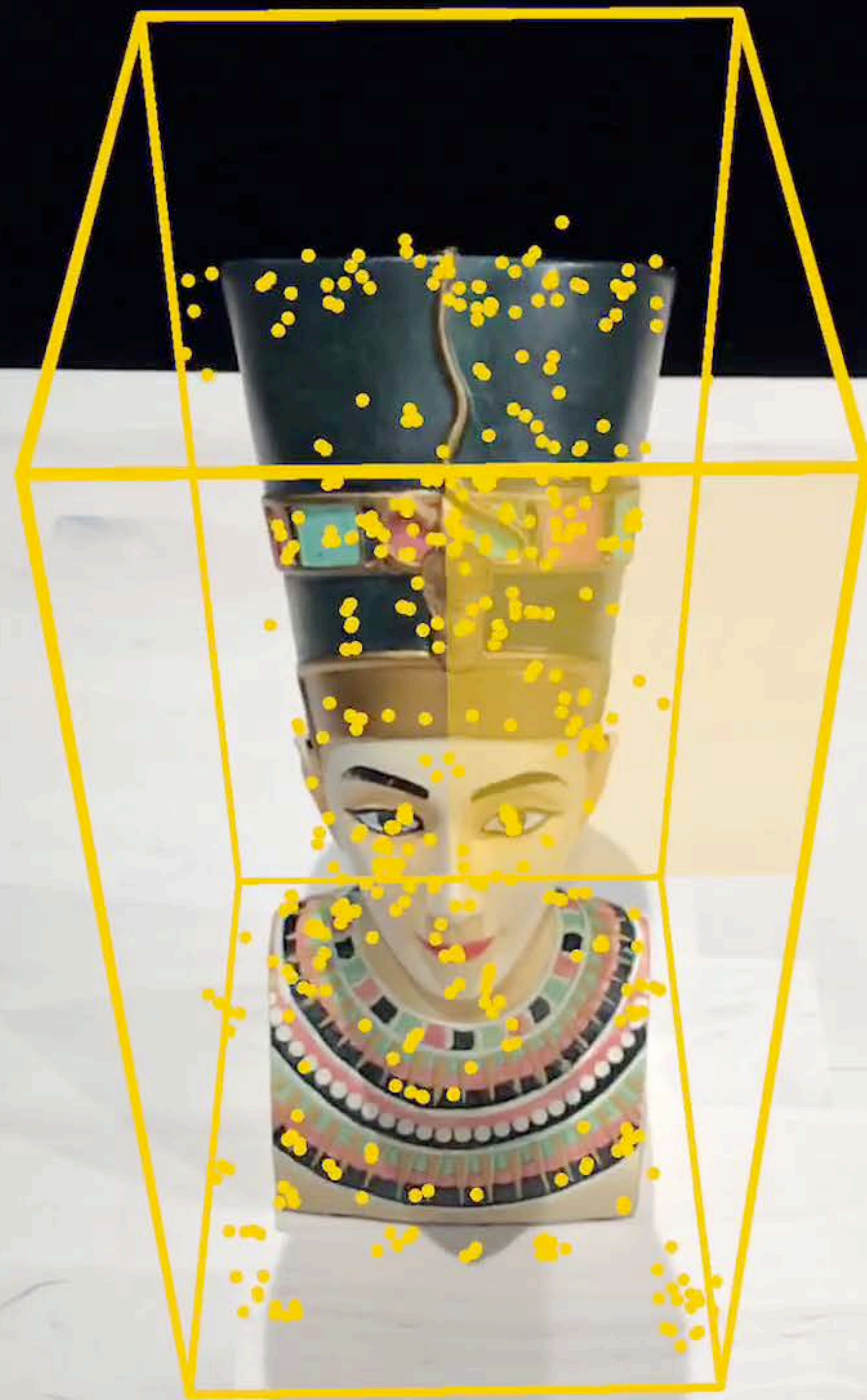
Scan the object from all sides that you are interested in. Do not move the object while scanning it! When done scanning, tap 'Stop'



Back

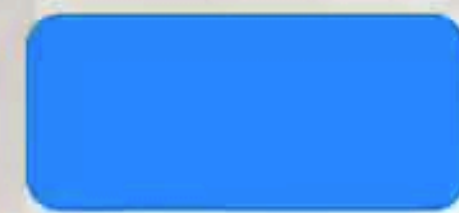
Scan (0%)

Restart



Scan the object

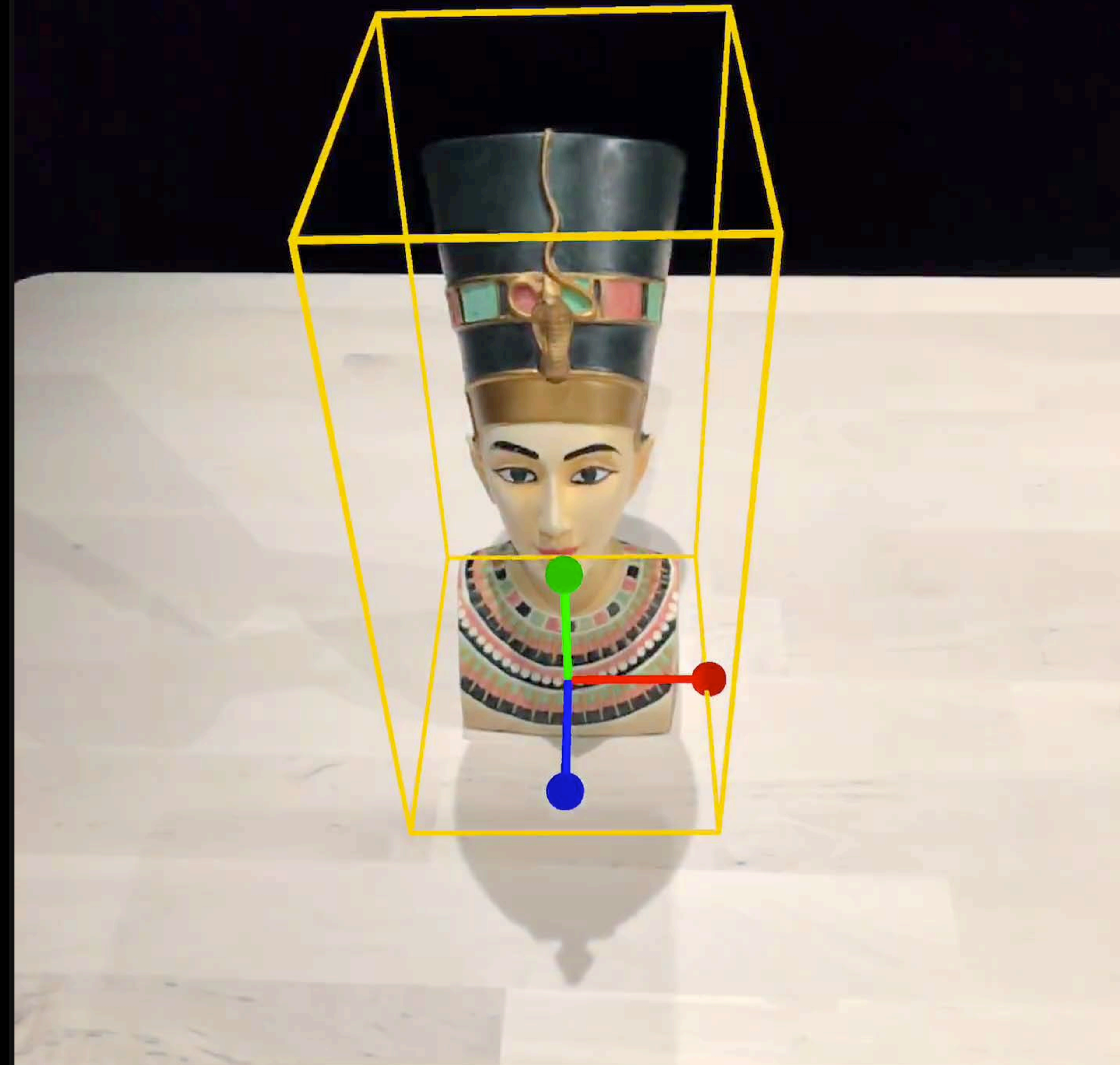
Scan the object from all sides that you are interested in. Do not move the object while scanning it! When done scanning, tap 'Stop'



Back

Adjust origin

Restart



Adjust origin

Touch one of the spheres and pan to move the origin along the selected axis, or rotate and move with two fingers. When satisfied, tap 'Test'. You can load a *.usdz 3D model overlay by tapping the 'Load Model' button.

Load Model

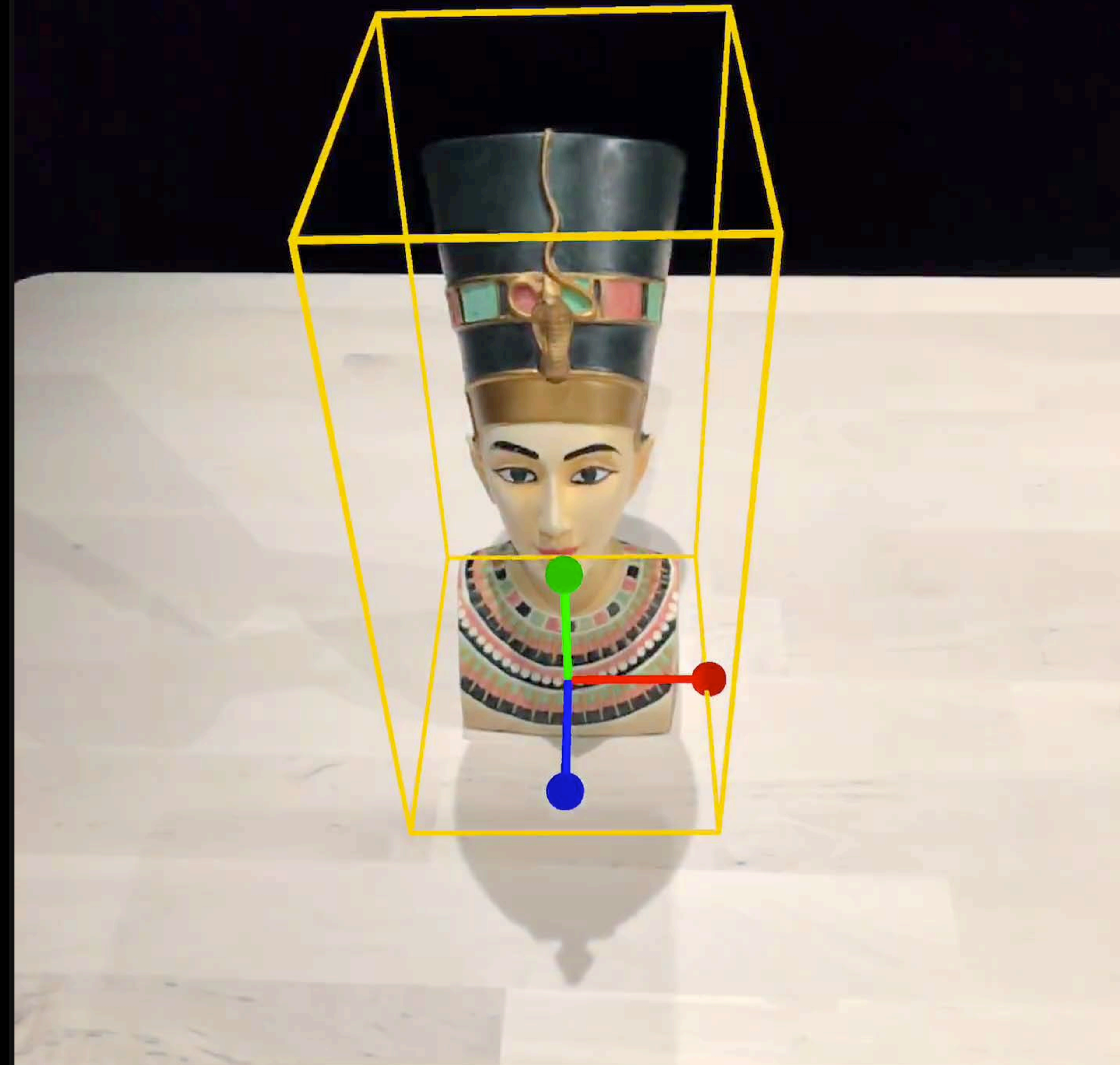
Test

?

Back

Adjust origin

Restart



Adjust origin

Touch one of the spheres and pan to move the origin along the selected axis, or rotate and move with two fingers. When satisfied, tap 'Test'. You can load a *.usdz 3D model overlay by tapping the 'Load Model' button.

Load Model

Test

?

Test

Restart

Scanning & detecting might not work:
ARKit is initializing



Point at the scanned object
Attempting to detect the scanned object.
Consider moving the object to different environments and testing there.

Light Off

Share

?

Scanning & detecting might not work:
ARKit is initializing



Point at the scanned object
Attempting to detect the scanned object.
Consider moving the object to different environments and testing there.

Light Off

Share

?

Test

Restart



Point at the scanned object
Attempting to detect the scanned object.
Consider moving the object to different environments and testing there.

Light Off

Share

?

Test

Restart



Point at the scanned object
Attempting to detect the scanned object.
Consider moving the object to different environments and testing there.

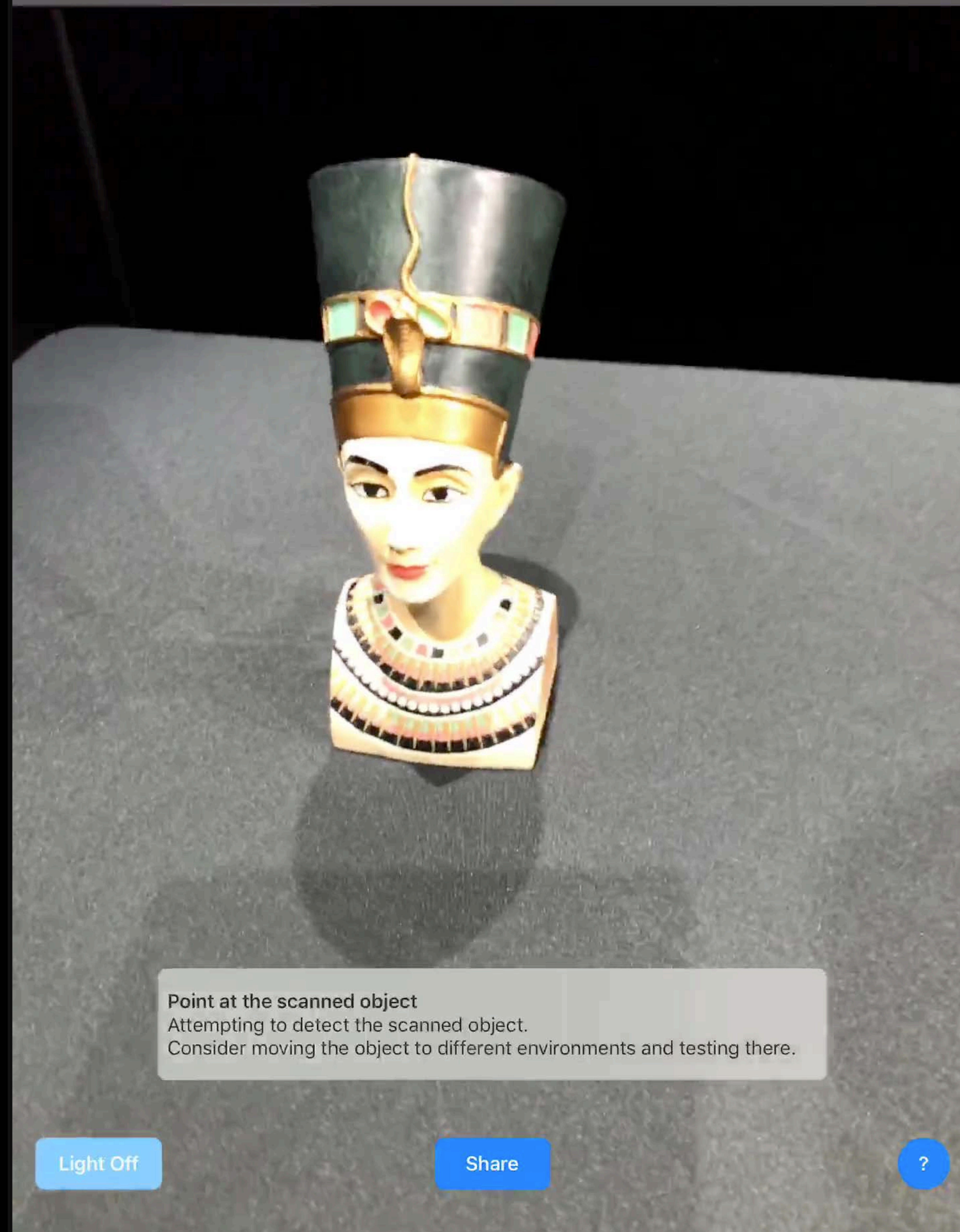
Light Off

Share

?

Test

Restart



Point at the scanned object
Attempting to detect the scanned object.
Consider moving the object to different environments and testing there.

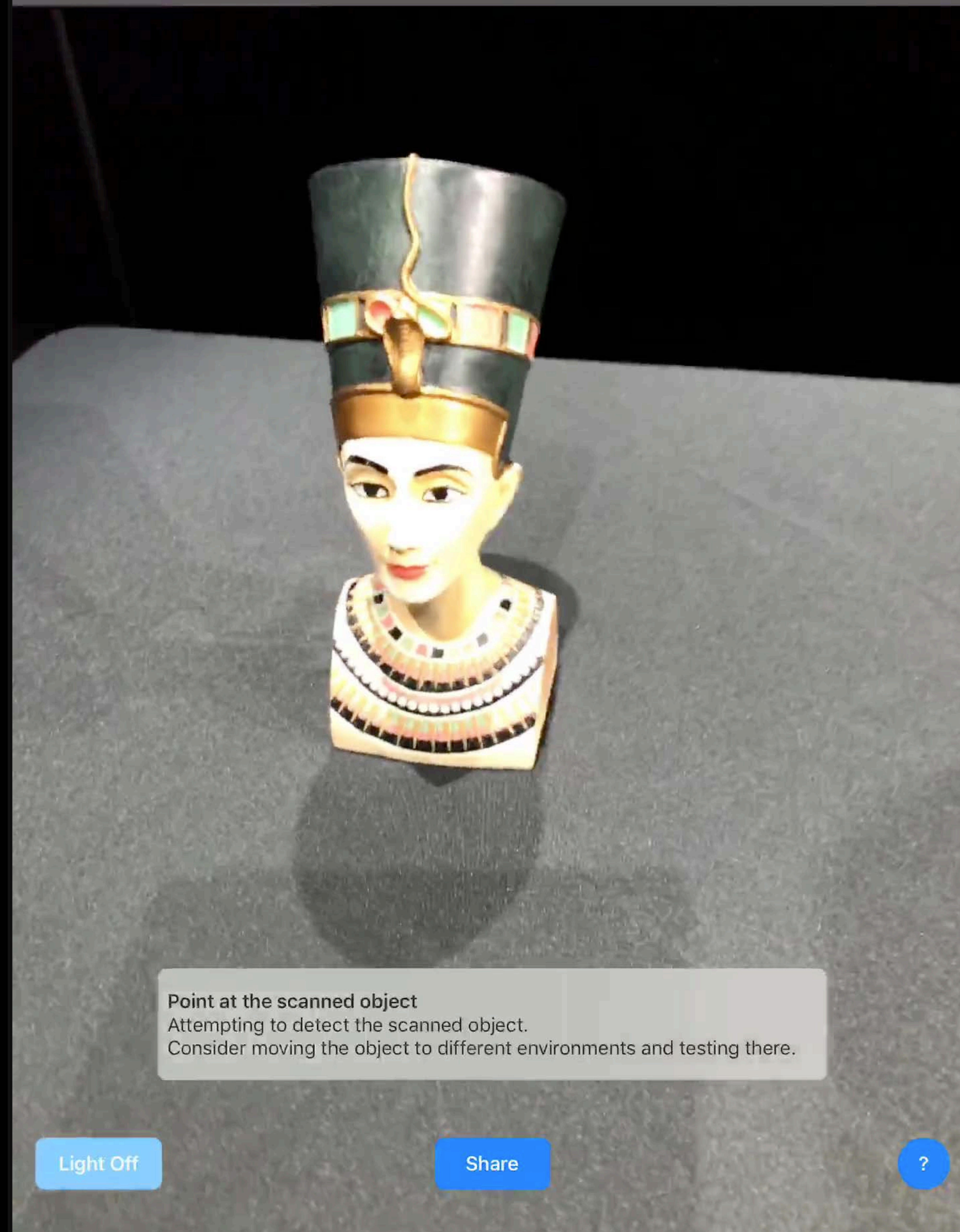
Light Off

Share

?

Test

Restart



Point at the scanned object
Attempting to detect the scanned object.
Consider moving the object to different environments and testing there.

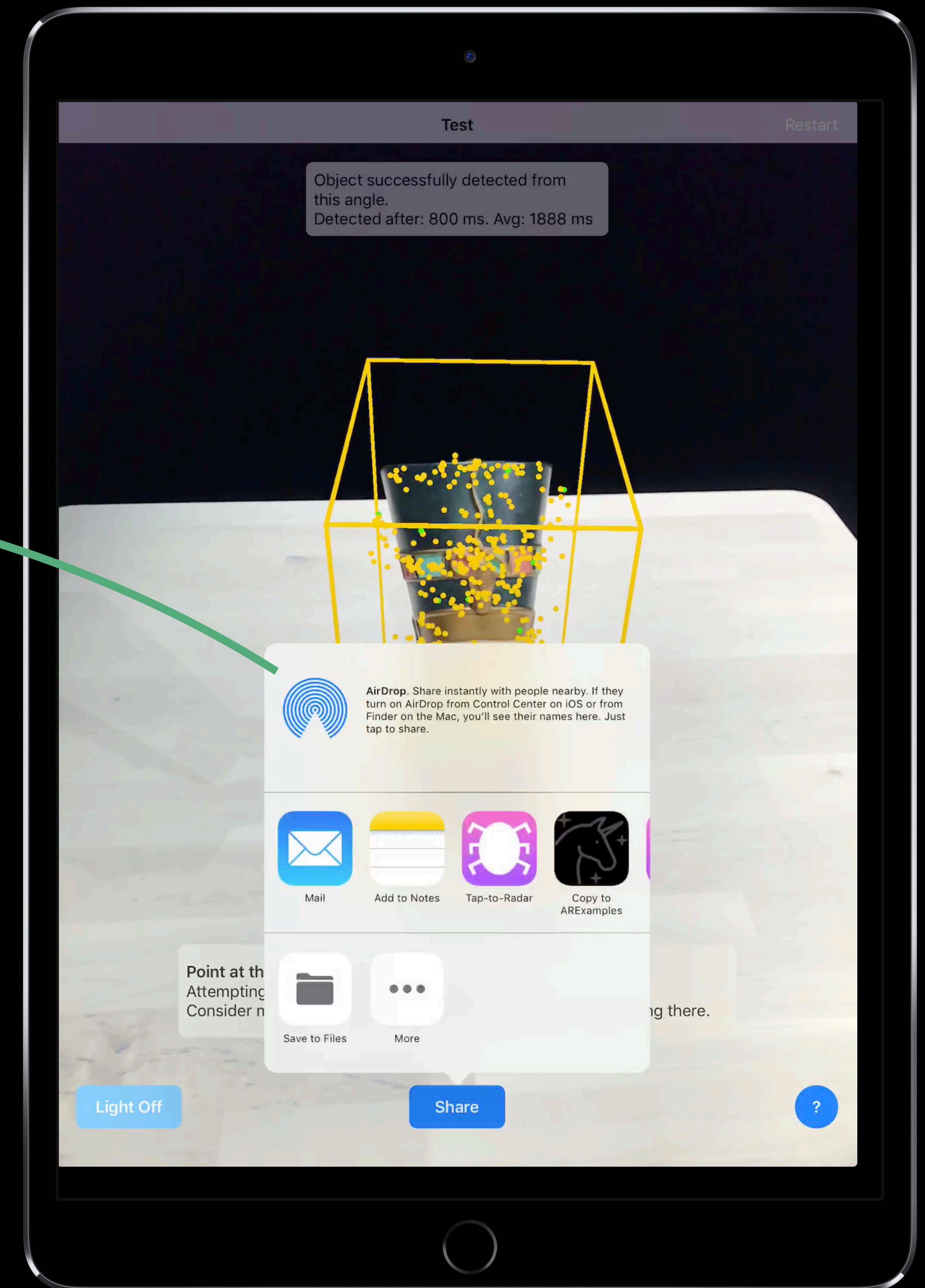
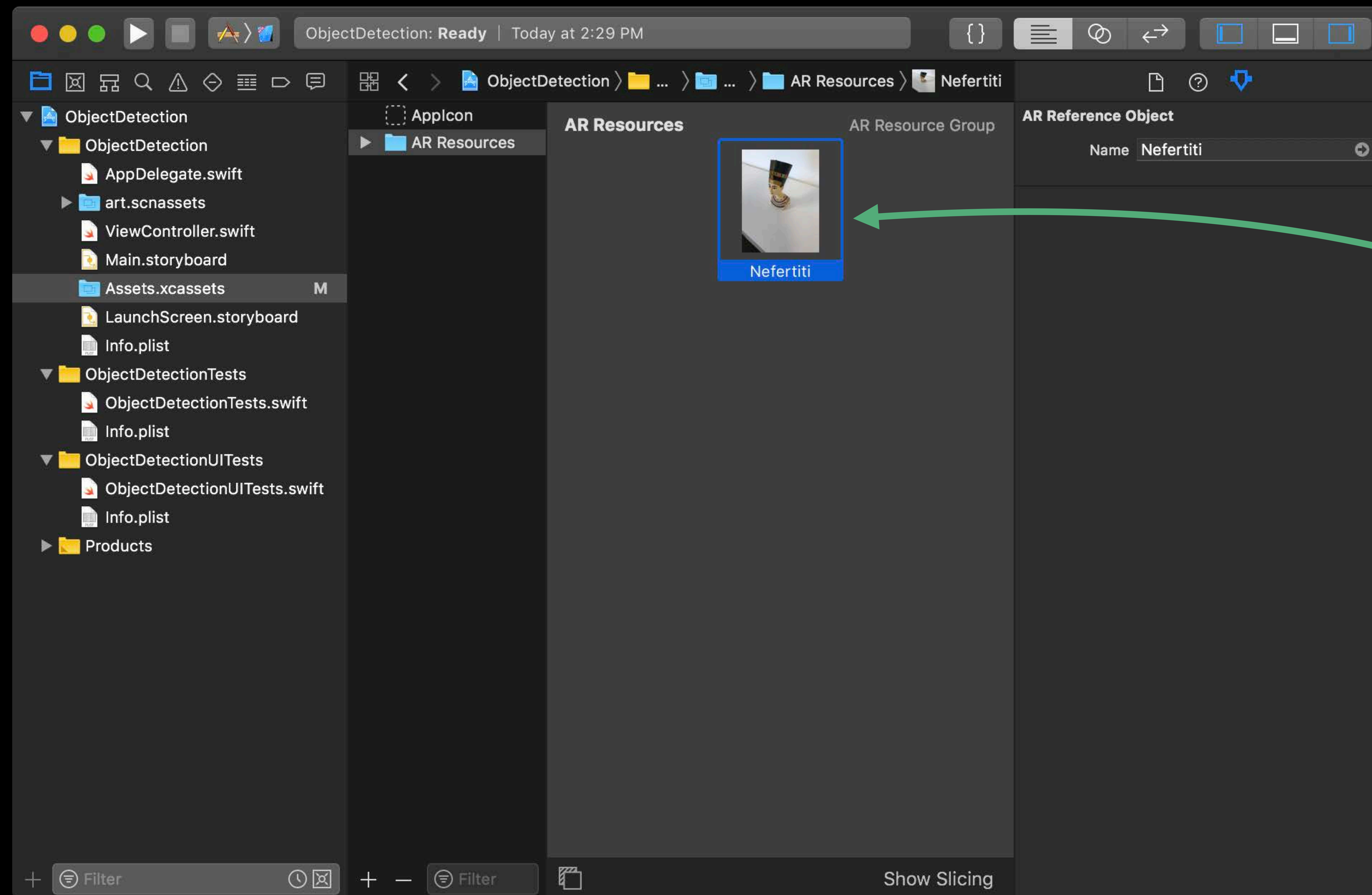
Light Off

Share

?

Object Scanning

Share ARReferenceObject



Good Objects to Track

Rigid objects

Texture rich

No Reflective

No Transparent





Scanning



Detection

Object Detection API

```
// Load Objects from Assets
let objects = ARReferenceObjects.referenceObjects(inGroupName: "Object", bundle: Bundle.main)
guard let objects = objects else {
    print("Error loading objects")
    return
}

// Create a session configuration
let configuration = ARWorldTrackingConfiguration()
configuration.detectionObjects = objects

// Run the session
let session = ARSession()
session.run(configuration)
```


Object Detection API

```
// Load Objects from Assets
let objects = ARReferenceObjects.referenceObjects(inGroupName: "Object", bundle: Bundle.main)
guard let objects = objects else {
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```
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Object Detection API

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```

```
// Run the session
let session = ARSession()
session.run(configuration)
```


Object Detection API

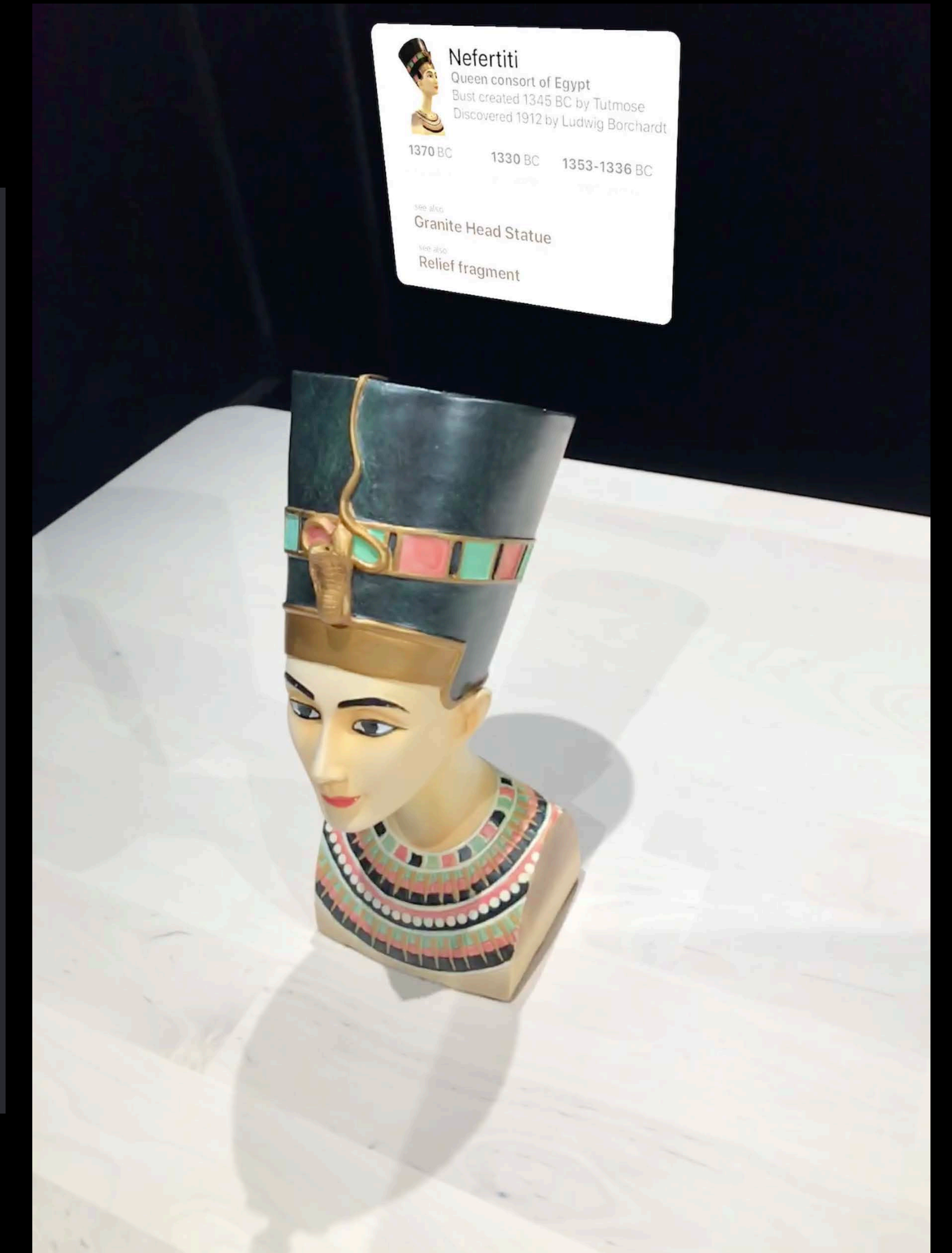
```
// Load Objects from Assets
let objects = ARReferenceObjects.referenceObjects(inGroupName: "Object", bundle: Bundle.main)
guard let objects = objects else {
    print("Error loading objects")
    return
}

// Create a session configuration
let configuration = ARWorldTrackingConfiguration()
configuration.detectionObjects = objects

// Run the session
let session = ARSession()
session.run(configuration)
```


Get Results

```
func session(_ session: ARSession, didUpdate anchors: [ARAnchor]) {  
    for anchor in anchors {  
        if let objectAnchor = anchor as? ARObjectAnchor {  
            let objectName = objectAnchor.referenceObject.name ?? ""  
            print("Object found: \(objectName)")  
        }  
    }  
}
```



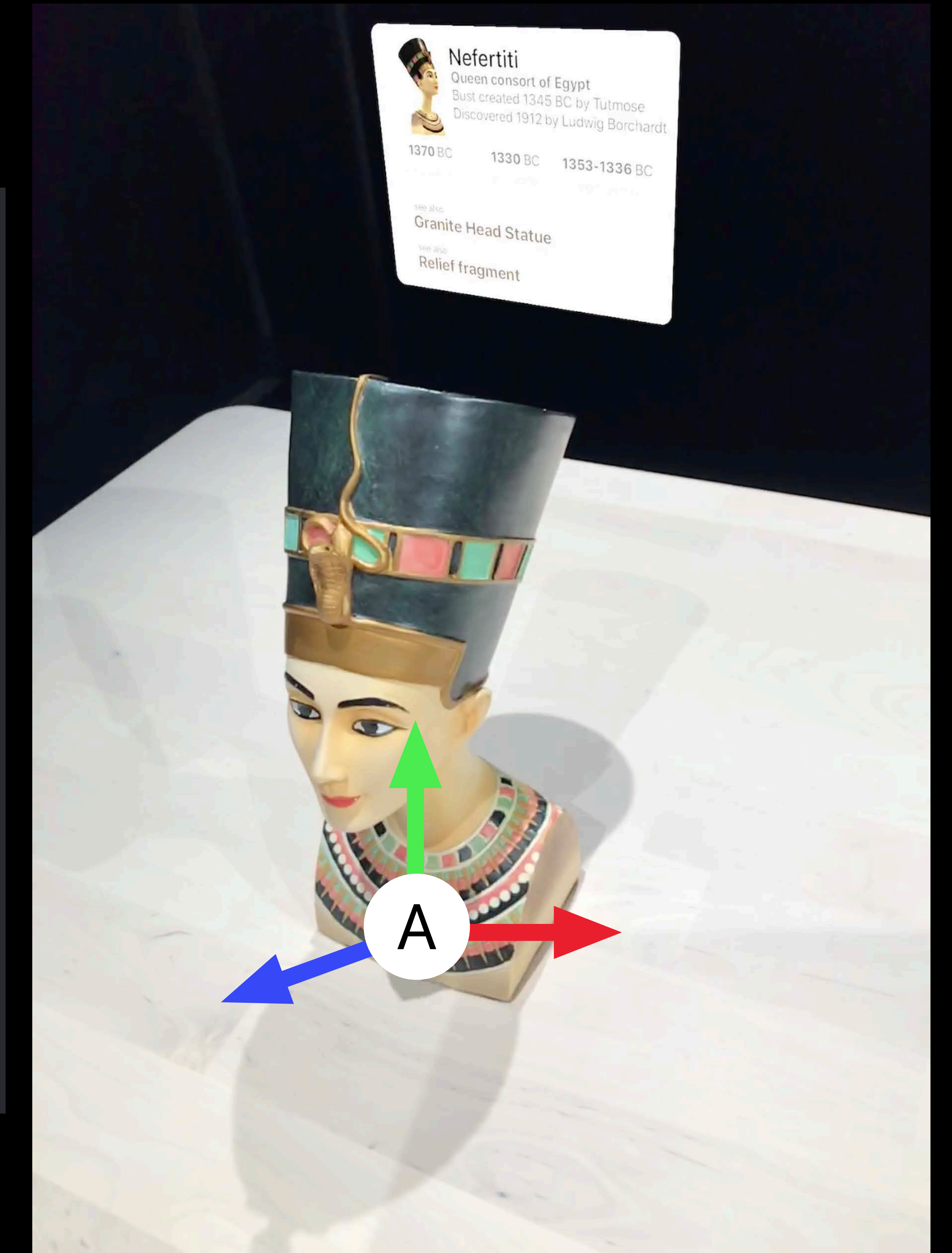
Get Results

```
func session(_ session: ARSession, didUpdate anchors: [ARAnchor]) {  
    for anchor in anchors {  
        if let objectAnchor = anchor as? ARObjectAnchor {  
            let objectName = objectAnchor.referenceObject.name ?? ""  
            print("Object found: \(objectName)")  
        }  
    }  
}
```



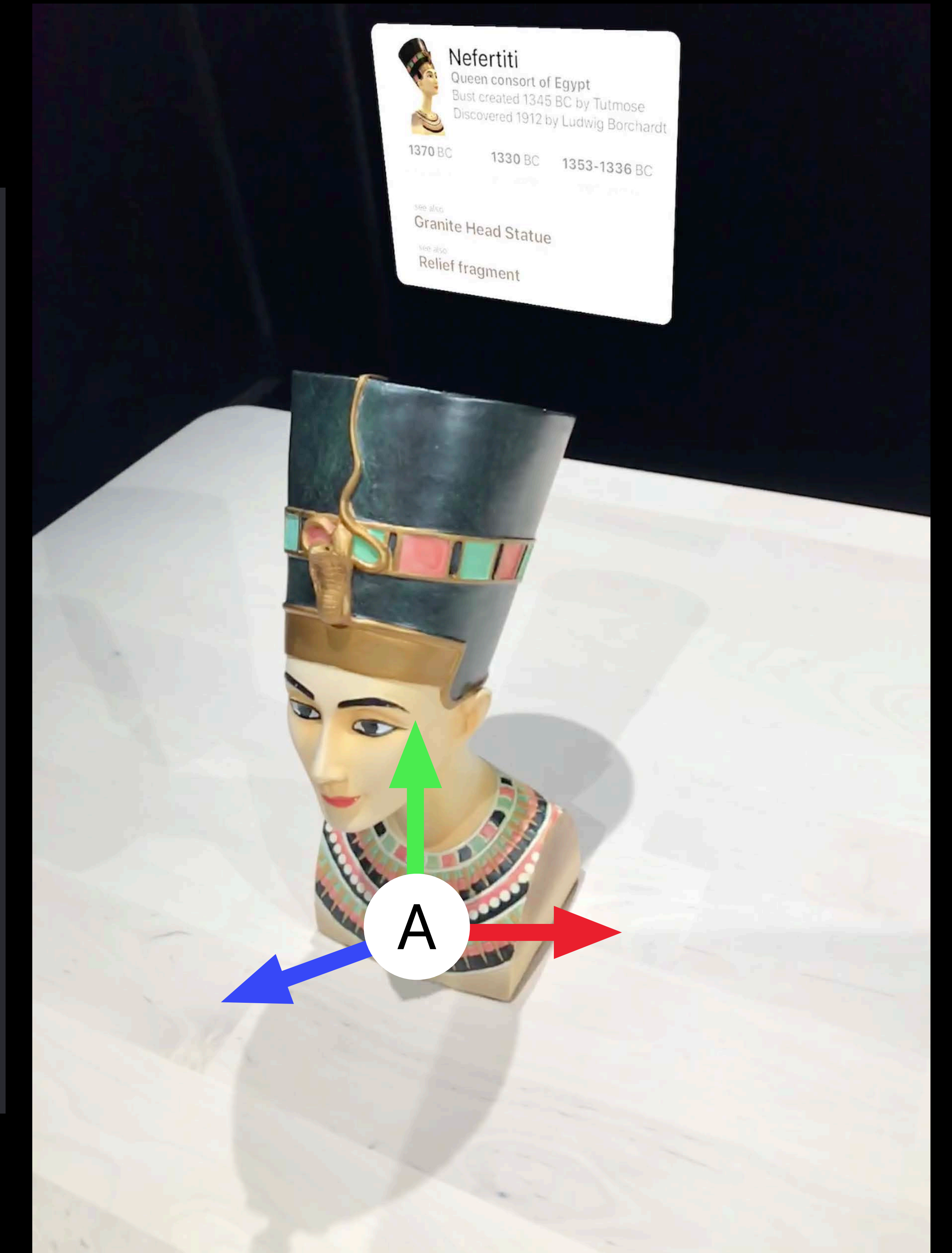
Get Results

```
func session(_ session: ARSession, didUpdate anchors: [ARAnchor]) {  
    for anchor in anchors {  
        if let objectAnchor = anchor as? ARObjectAnchor {  
            let objectName = objectAnchor.referenceObject.name ?? ""  
            print("Object found: \(objectName)")  
        }  
    }  
}
```



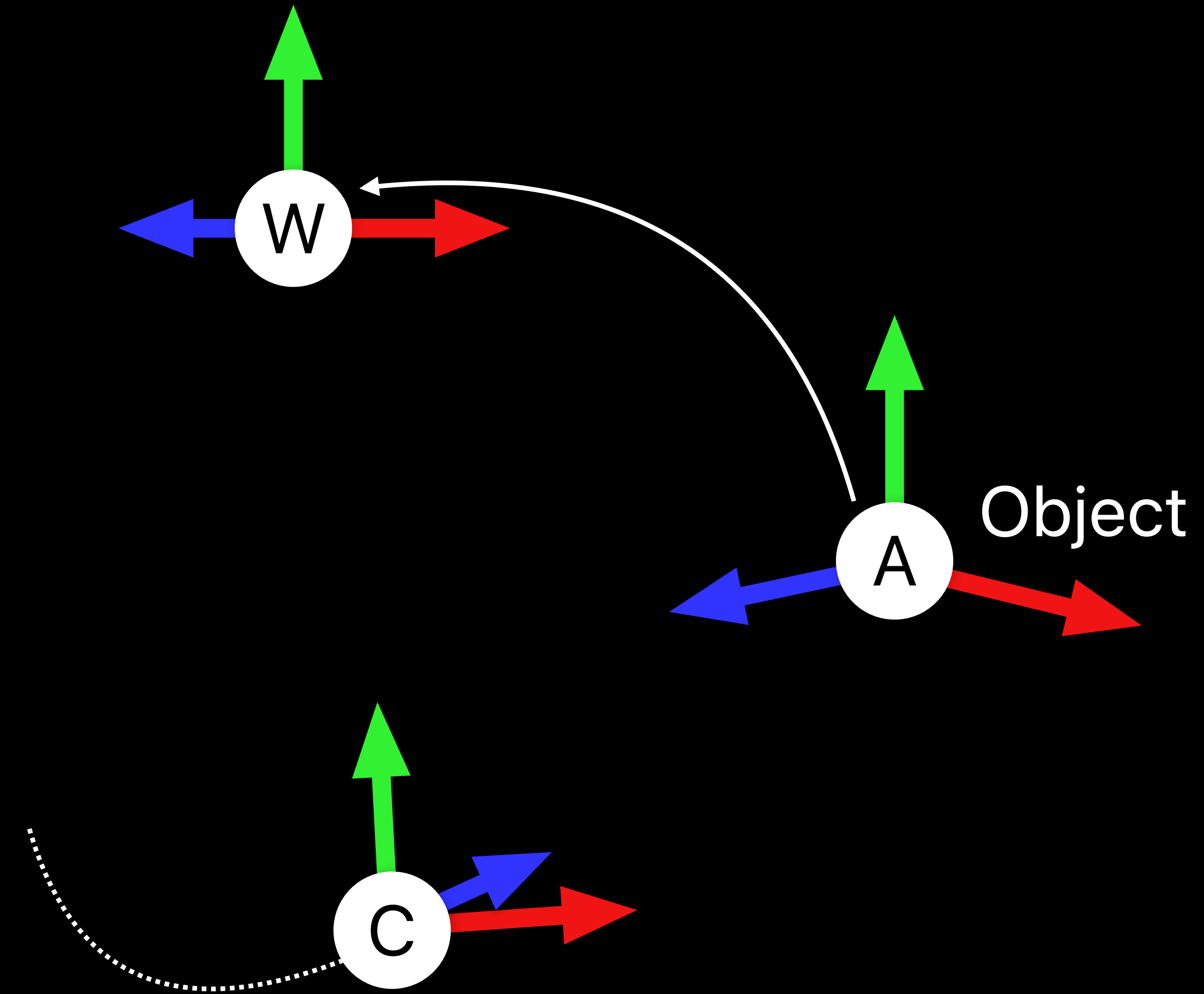
Get Results

```
func session(_ session: ARSession, didUpdate anchors: [ARAnchor]) {  
    for anchor in anchors {  
        if let objectAnchor = anchor as? ARObjectAnchor {  
            let objectName = objectAnchor.referenceObject.name ?? ""  
            print("Object found: \(objectName)")  
        }  
    }  
}
```



Object Detection vs. World Map Relocalization

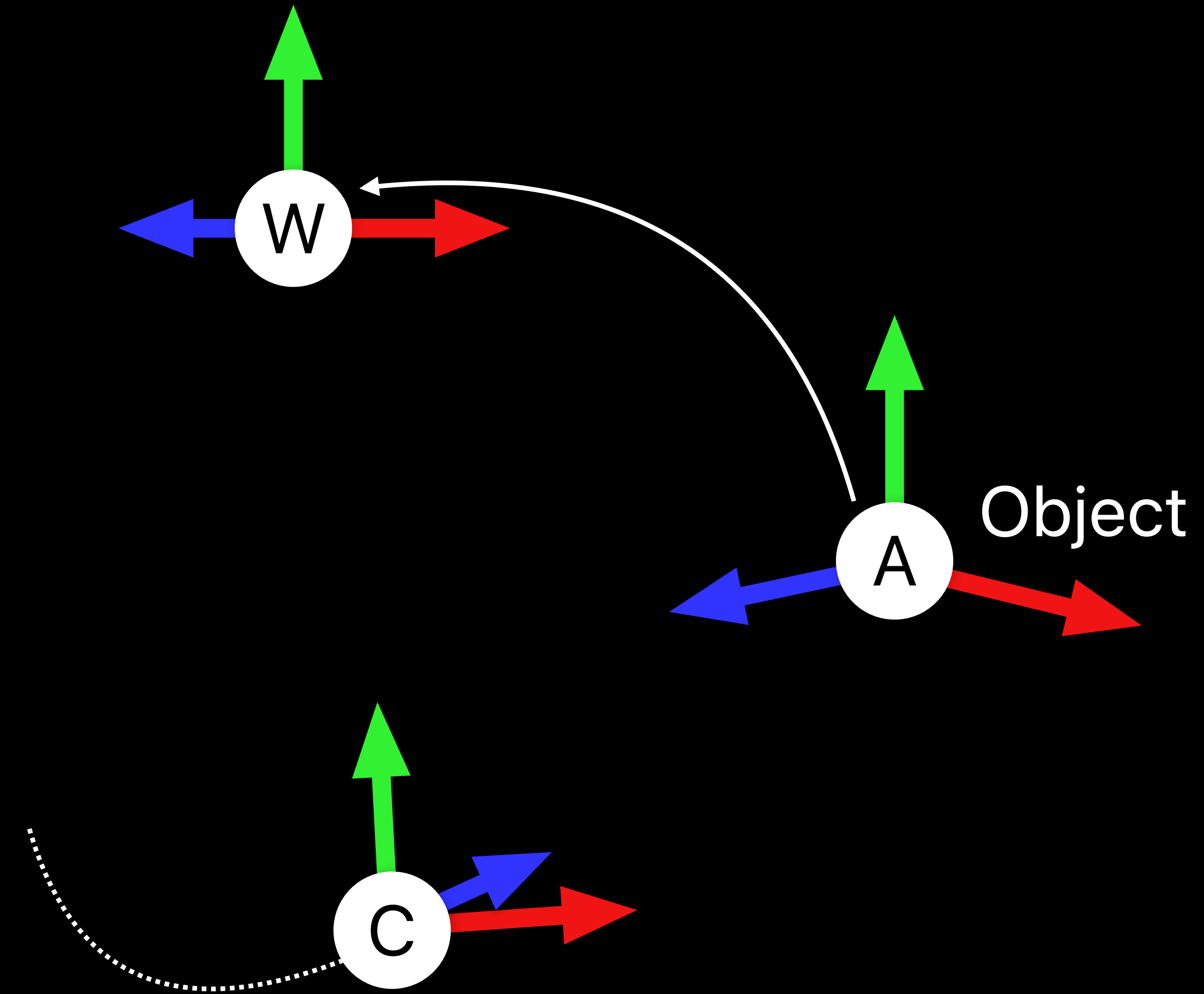
Object Detection



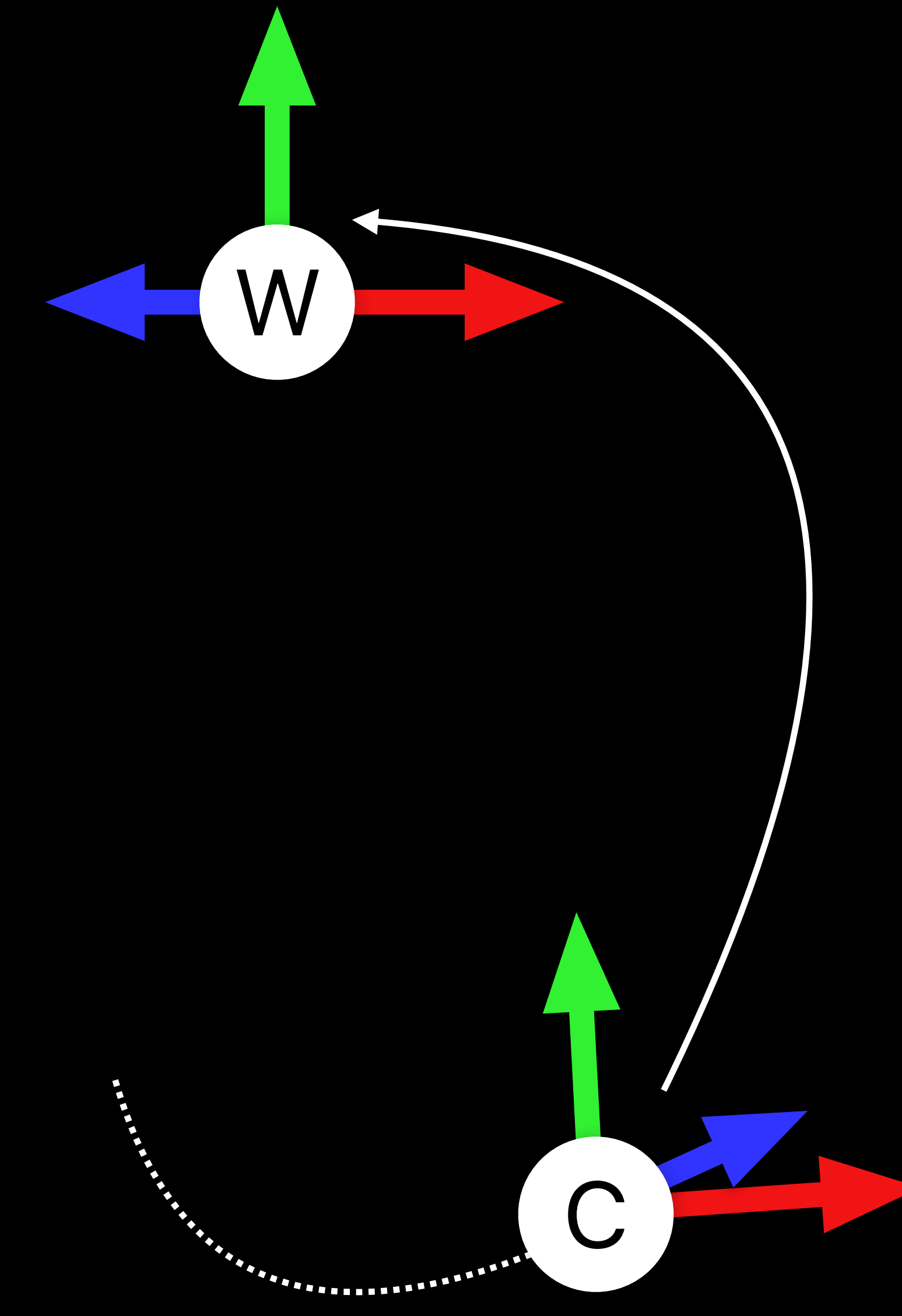
World Map Relocalization

Object Detection vs. World Map Relocalization

Object Detection

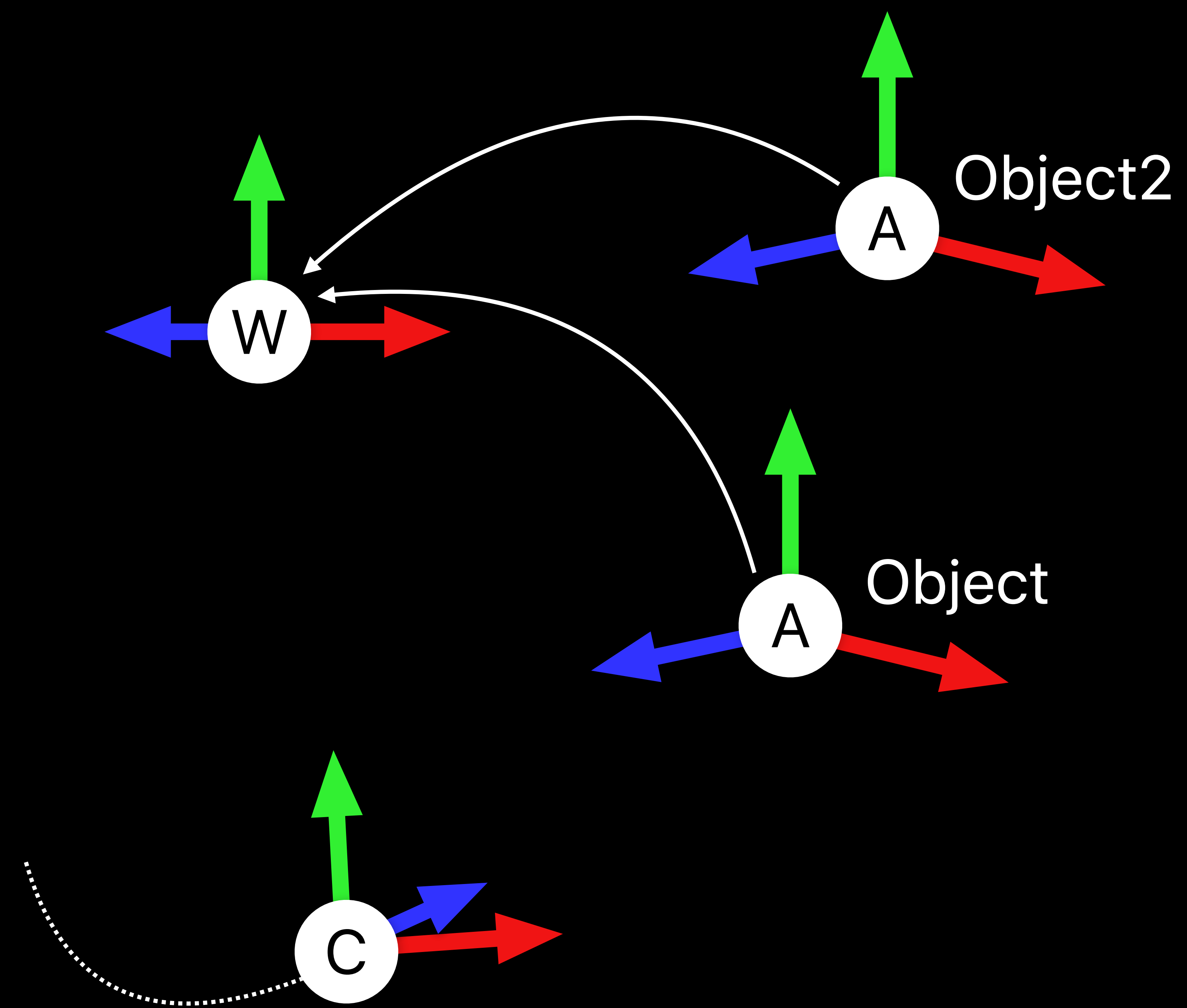


World Map Relocalization

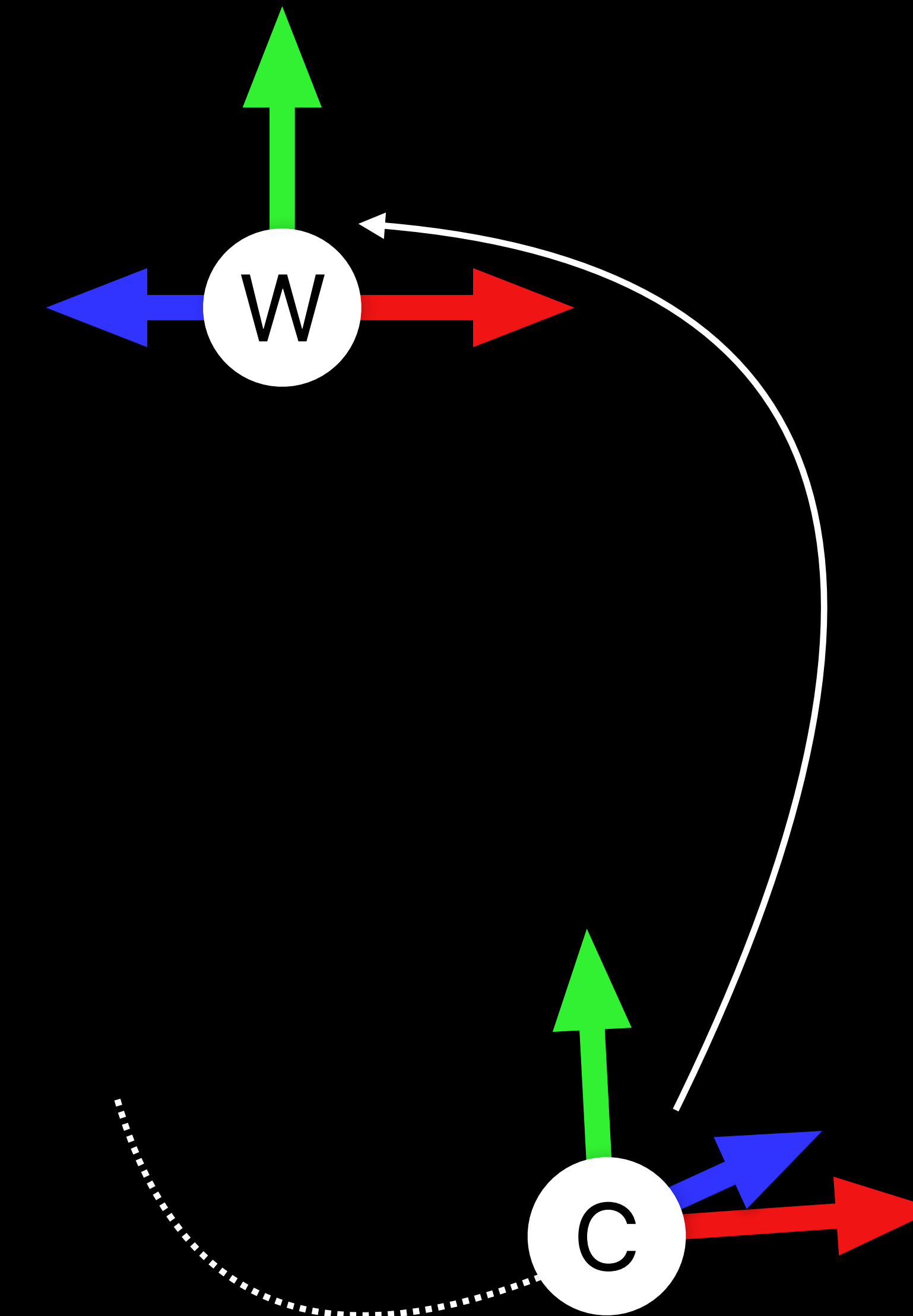


Object Detection vs. World Map Relocalization

Object Detection

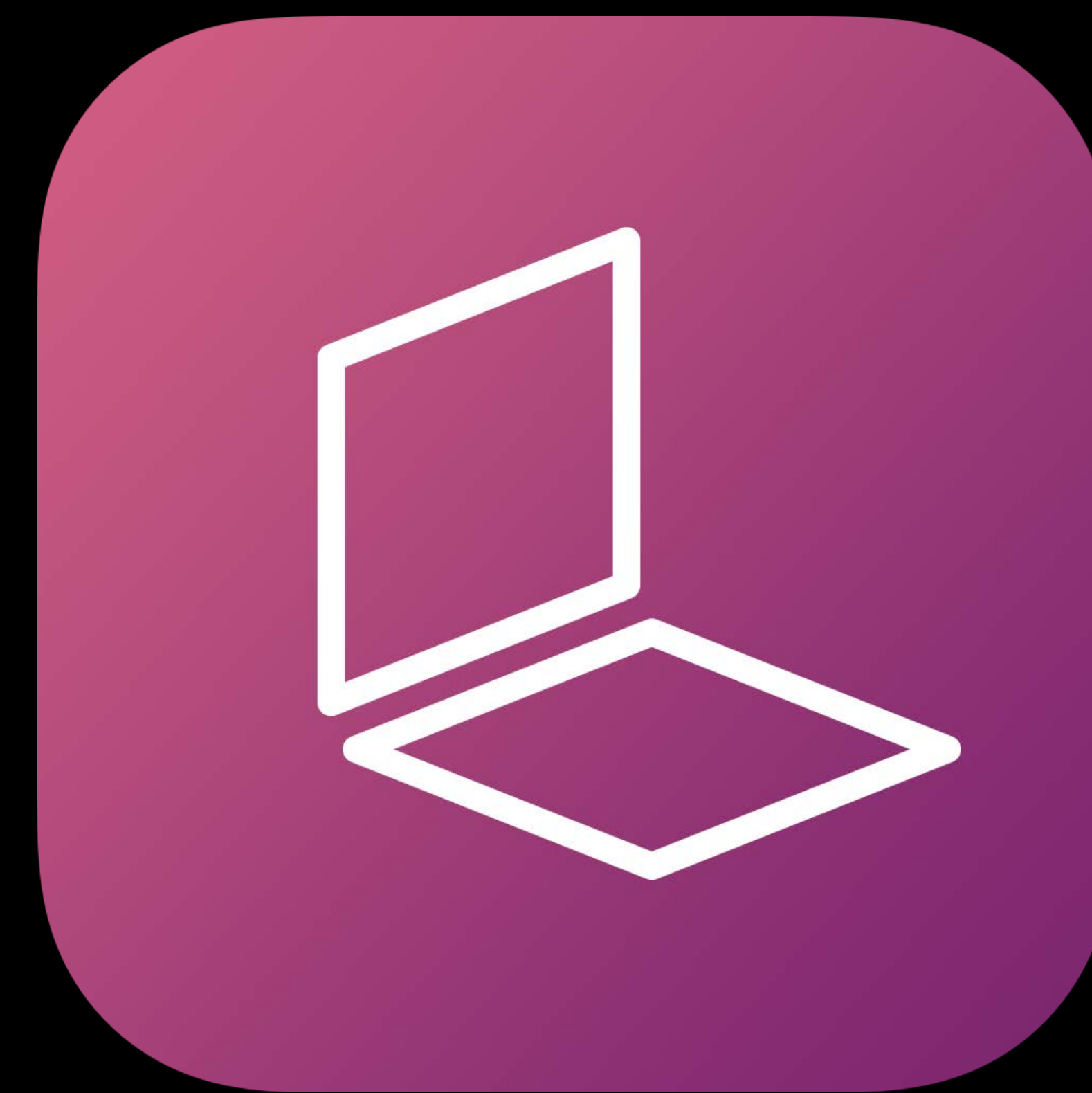


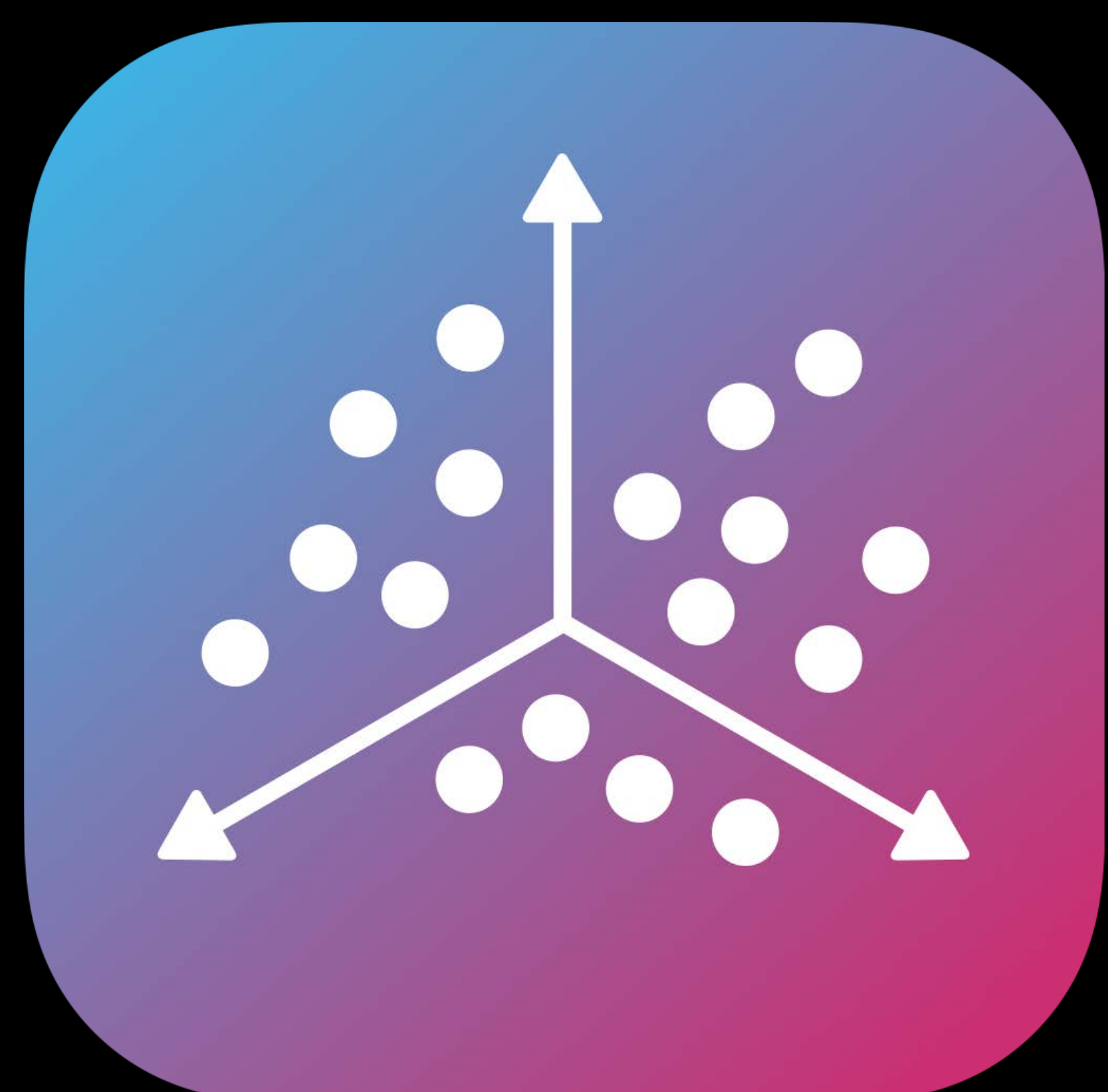
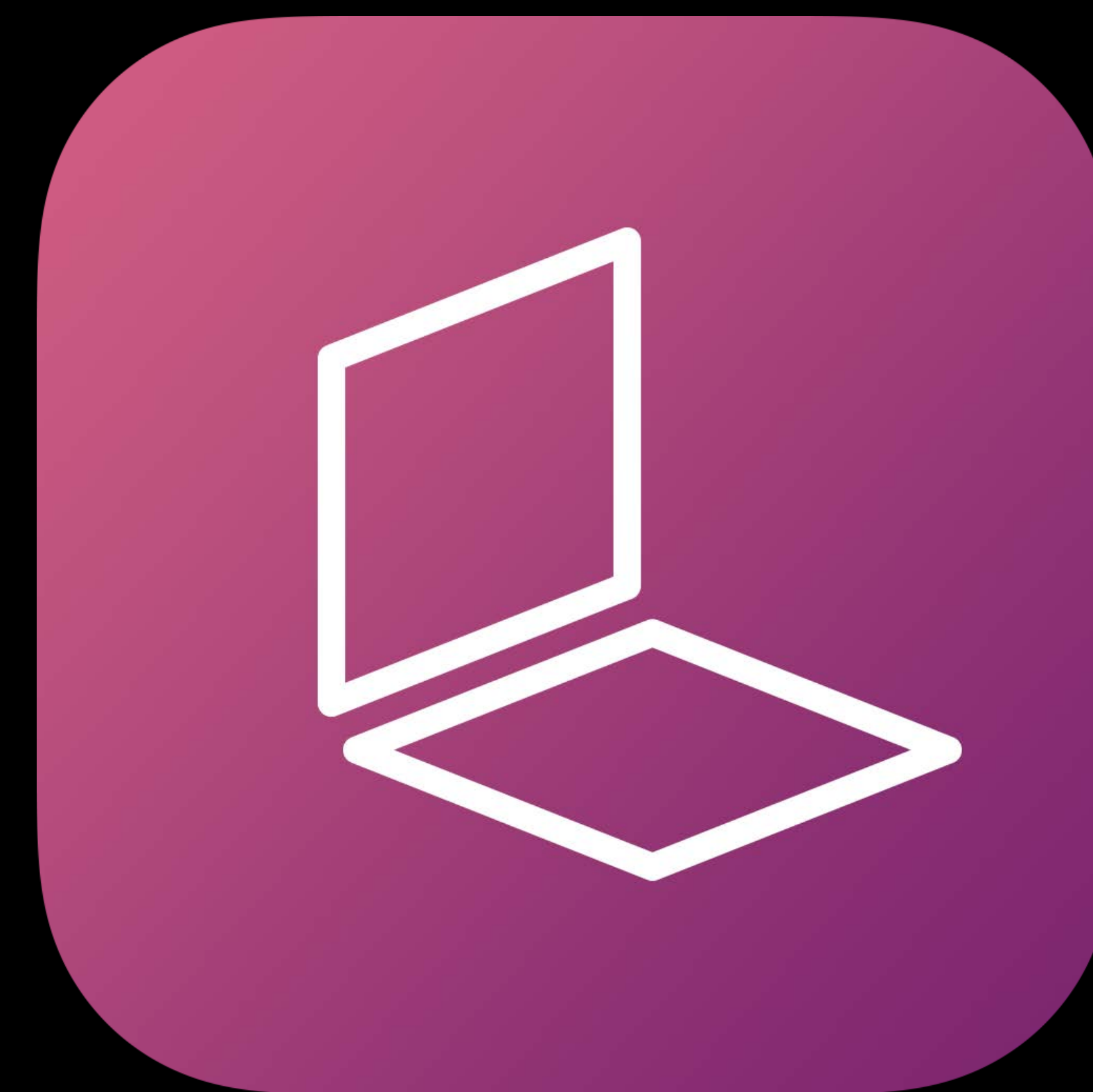
World Map Relocalization

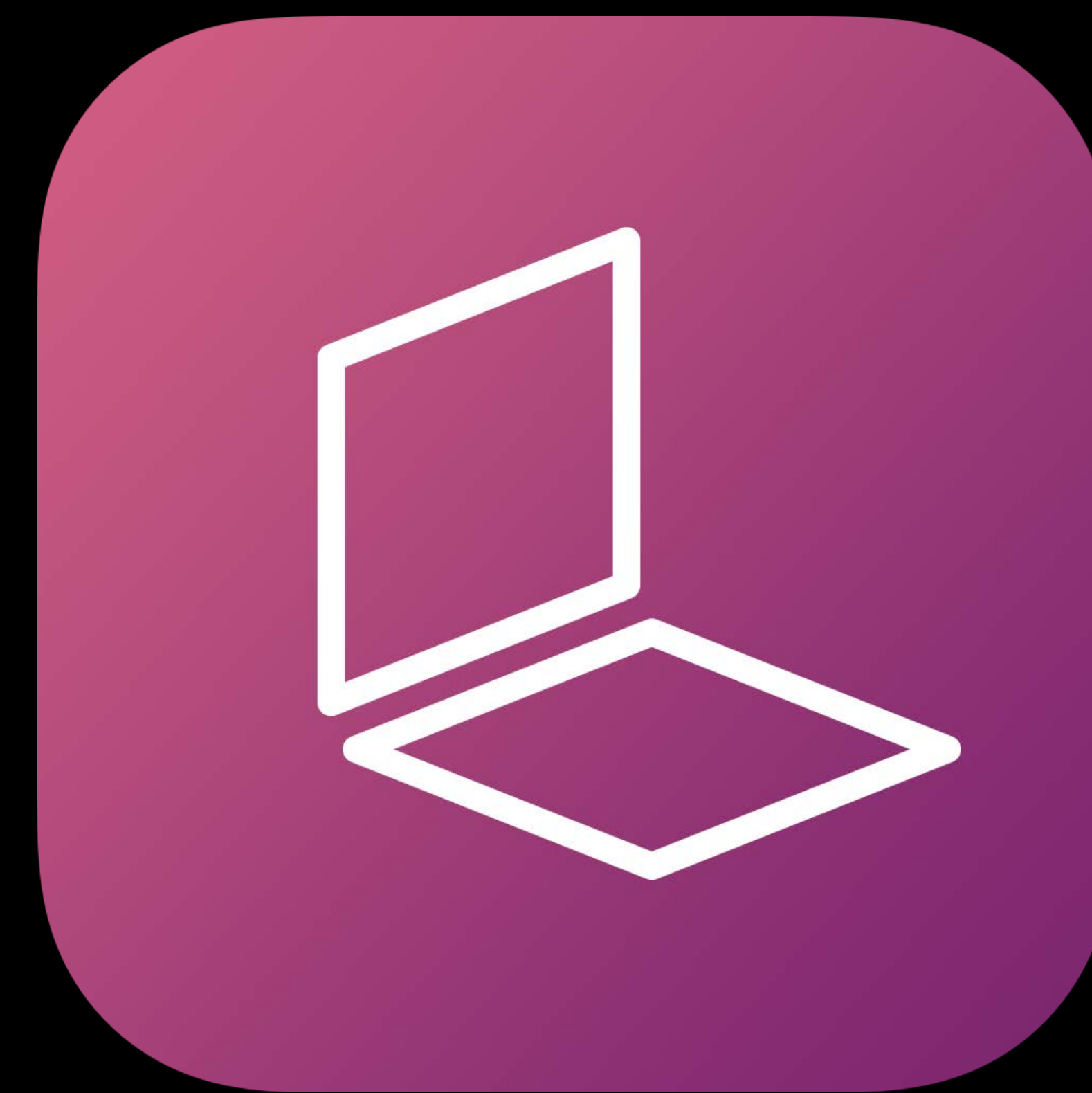


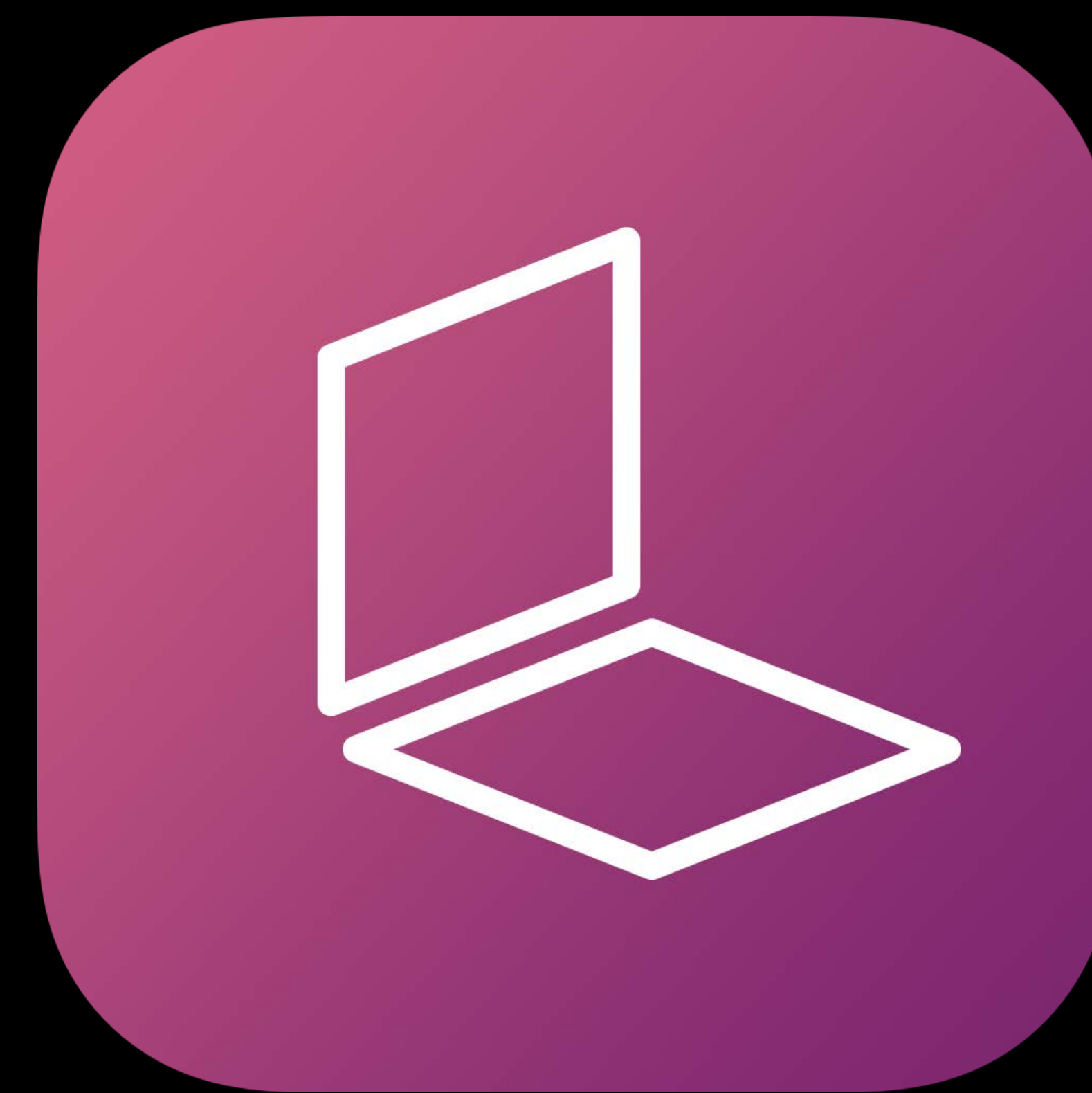












More Information

<https://developer.apple.com/wwdc18/610>

ARKit Lab

Technology Lab 6

Friday 9:00AM

 **WWDC18**