

Open-LIFU* Photogrammetry App User Manual

Openwater



Disclaimer

The Open-LIFU Photogrammetry App is for research use only. Not for use in diagnostic or therapeutic procedures. All information contained herein, including but not limited to product features, specifications, and descriptions, is subject to change without notice.

Document ID: LBL-00017

Revision: A

Software Version: 0.7.257

Author(s): Seemal Tahir, David Paribello, & Peter Hollender

*The Open-LIFU Photogrammetry App is for Research Use Only. Not for use as a diagnostic or therapeutic tool.

Contents

Contents.....	2
Software Overview.....	3
Open-LIFU Photogrammetry App.....	3
Intended Use.....	3
Definitions.....	3
Warnings and Precautions.....	4
Warnings.....	4
Precautions.....	4
Getting Started.....	4
System Requirements.....	4
Install the Open-LIFU Photogrammetry App (Android only).....	5
Enable Developer Mode and USB Debugging.....	5
ADB Enabling.....	5
Photogrammetry Workflow.....	6
Photocollection Best Practices.....	6
Recommended Capture Method (Online and Offline).....	6
Running the Open-LIFU Photogrammetry App.....	9
Online Mode: Cloud Reconstruction.....	9
Option 1 Online Mode: Full Internet Access.....	11
Option 2 Online Mode: Limited Internet Access.....	14
Offline Mode: Local Reconstruction.....	16
Viewing and Managing Photocollections.....	19
Customer Support.....	19
Troubleshooting.....	20
Appendix.....	24
Sine Wave Capture Method.....	24

Software Overview

The Open-LIFU Photogrammetry App is designed to capture images of a subject (photocollection), which are then used for photogrammetric reconstruction (photoscan). Once captured, these images can be imported or synced with the Open-LIFU application and co-registered with a subject's MRI for targeted LIFU procedures.

Open-LIFU Photogrammetry App

The Open-LIFU Photogrammetry App runs on an Android device. When initiating a scan, the user enters an ID that allows the scan to be identified as belonging to the current study. Once started, the Open-LIFU Photogrammetry App automatically captures images and provides feedback to the user on how to position (or angle) the camera with respect to the subject. Once the scan is complete, the user can connect the phone to a PC (offline) or Openwater's Cloud Services (online) for 3D reconstruction.

Intended Use

The Open-LIFU Photogrammetry App is intended to be used with the Open-LIFU System for research use only. It captures photocollections that are reconstructed into a 3D photoscan and used to register the transducer position to a subject's MRI. The app and the associated Cloud Services are not cleared or approved by the FDA, are not intended for the diagnosis or treatment of any disease or condition, and should not be used as a basis for clinical decision-making.

Definitions

ADB (Android Debug Bridge): A command-line tool that lets the PC communicate with the phone over a USB connection. The Open-LIFU Desktop Application uses ADB to transfer photocollections from the phone.

Cloud Services: Openwater's optional subscription service that reconstructs photocollections in the cloud and sends the photoscan to the Open-LIFU Desktop Application.

Credit: A unit of Cloud Services usage. Each cloud reconstruction uses one credit.

LIFU: Low intensity focused ultrasound

Offline Mode: Using the app without signing in. Photocollections are transferred to the PC by USB cable and reconstructed locally.

Online Mode: Using the app while signed into a Cloud Services account. Photocollections are reconstructed in the cloud.

Photocollection: A series of images captured of a subject. Used to reconstruct a Photoscan.

Photoscan: A reconstructed 3D mesh representing the scanned surface of a Subject. Also referred to as photogrammetry mesh or 3D mesh.

Session: An instance of sonication planning for a Subject.

Subject: The person/animal/phantom being sonicated.

Subject Scan ID: The ID generated by the Open-LIFU Desktop Application that links a photocollection to the correct subject and session.

Transducer: The assembly containing one or more Transmit Modules in a durable housing.

Veneer: The patterned outer face of the Transducer which is used during the photocollection step.

Warnings and Precautions

Warnings

 Warning: If the position of the transducer shifts on the subject during or after session planning, sonication may target unintended locations. If the transducer shifts, recapture the photocollection and repeat session planning.

 Warning: Inaccurate photoscans can result in poor image registration, leading to off-target sonication and/or unintended outcomes. Verify all photoscans and image registration accuracy before beginning.

Precautions

Plan cable routing before capturing photogrammetry mesh and commencing sonication. Place cables so they do not pose a tripping hazard to anyone in the room.

Keep the area around the subject well lit and clear of any tripping hazards so that the user can safely walk a full circle around the subject during capture.

Do not remove or damage the transducer veneer, and do not clean it with isopropyl alcohol. The patterned veneer is used to localize the transducer in the photoscan.

Getting Started

System Requirements

A mobile device with a camera is required to capture photocollections. Official support is provided for Google Pixel phones, and the Open-LIFU Photogrammetry App has been tested on the Pixel 5, 7, 9, and 10. Additional phones that meet the minimum specifications may also work, e.g. Samsung Galaxy A16 or Motorola moto g; however, phones other than Google Pixel

are not officially supported¹.

Minimum phone specifications:

- Android phone running Android 14 or newer
- Dual Camera: 12.2 MP, f/1.7, 27mm (wide), 1/2.55", 1.4µm, dual pixel PDAF, OIS 16 MP, f/2.2, 117° (ultrawide), 1.0µm
- Accelerometer, gyro

A PC running the [Open-LIFU Desktop Application](#) or [Slicer Open-LIFU](#) is also required. Refer to the [LBL-00009 Open-LIFU User Manual](#) for PC requirements. A GPU is only needed for local (Offline Mode) reconstruction. A USB-C cable is required to transfer photocollections from the phone to the PC in Offline Mode and in Online Mode Option 2.

Install the Open-LIFU Photogrammetry App (Android only)

1. Open the Google Play Store on the phone.
2. Search for "OpenLIFU" (by Openwater) or click the link below
[Open-LIFU Photogrammetry App](#)
3. Install the application and enable automatic updates for optimal performance.

Enable Developer Mode and USB Debugging

1. On the phone, navigate to Settings → About Phone, and scroll down to see the Build Number.
2. Tap Build Number 7 times or until you see "You are now a developer!".
3. Go to Settings → System → Developer options.
4. Enable USB debugging.
5. If prompted, allow USB debugging access to your computer. (Check "Always allow" to avoid repeated prompts.)

USB debugging is required to transfer photocollections from the phone to the PC over USB.

NOTE: This step is only needed if transferring files from the phone to the PC over USB.

ADB Enabling

1. In the Open-LIFU Desktop Application, the login page has a button that installs ADB and the necessary Android tools. Install these tools before transferring images over USB or proceeding with local reconstruction.

¹ Users with an unsupported phone are encouraged to visit Openwater's Discord and join the [Photogrammetry channel](#).

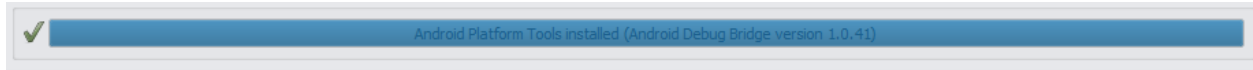


Figure 1: Confirmation in the Open-LIFU Desktop Application that the Android Platform Tools (ADB) are installed. ADB is required before photocollections can be transferred to the PC over USB.

Photogrammetry Workflow

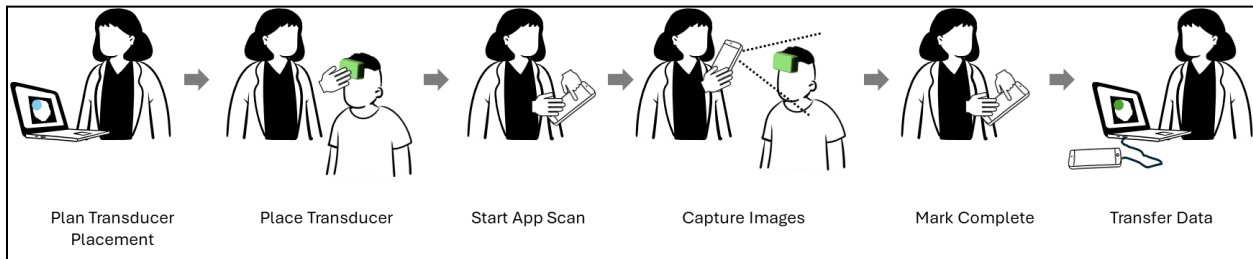


Figure 2: Overview of the photogrammetry workflow: plan the transducer placement, place the transducer on the subject, start the scan in the app, capture images, mark the scan complete, and transfer the data to the PC.

Photocollection Best Practices

When capturing a photocollection, follow these best practices:

1. Seat the subject in a comfortable, slightly reclined position (neck support is recommended, but the neck rest should not block or obscure the back of the head).
2. Minimize background noise: capture in a well-lit area that is free of clutter, with no people moving in the background.
3. The subject should keep their eyes closed while the images are collected.
4. Get as close as possible to the subject. Fill as much of the on-screen oval as possible with the subject's head and the transducer.
5. Complete a full 360° circle around the subject, walking counterclockwise as instructed by the app.
6. Maintain a slow and steady pace and do not stop part way through. Make sure each image is captured (the "bucket" turns green) before moving on to the next image, to avoid blurring.
7. Capture the full 120 images.

NOTE: Photocollections with fewer than 120 images may produce low-quality reconstructions.

Recommended Capture Method (Online and Offline)

When starting capture, ensure the phone is facing the front of the subject. Please make sure the subject is leaning back in a reclining position at a slight angle for capture. This may be done with the subject leaning in a reclining chair with a neckrest.

Move the phone in a “sine wave” fashion as you walk counterclockwise around the subject:

1. Start by facing the subject and then begin walking counterclockwise.
2. Slowly lower the phone as you reach the left side of the subject, making sure to fully capture the left side of the transducer.
3. Gradually start to raise the phone as you reach the back of the head to capture the top of the transducer. Having the subject in a reclined position will assist with this part of the capture.
4. Continue moving around to the subject’s right side, and slowly lower the phone to get a complete view of the right side of the transducer.
5. As you complete the full circle, slowly raise the phone so it is level with the subject’s head once again.

This process captures the front, sides, and top views of the transducer and ensures complete coverage of the head and transducer from various angles. This method is clearly illustrated in the [Appendix](#).

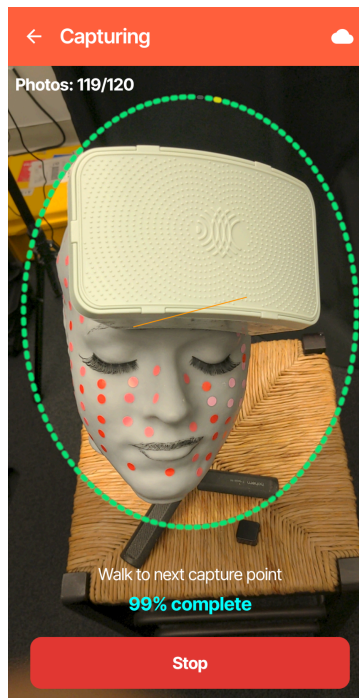


Figure 3: Front view, captured straight on with the subject’s face and the front of the transducer filling the on-screen oval (steps 1 and 5).

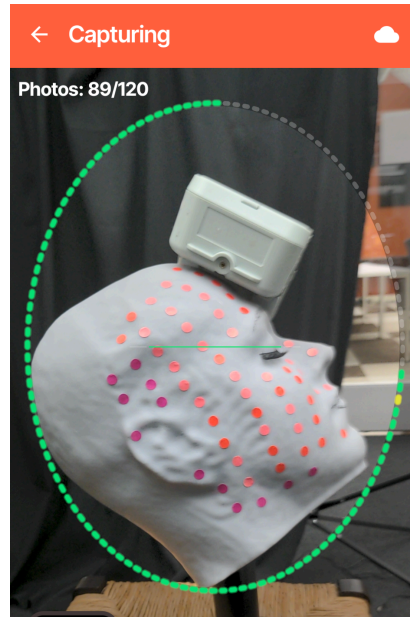


Figure 4: Side view, captured with the phone lowered to show the full side of the transducer (steps 2 and 4).

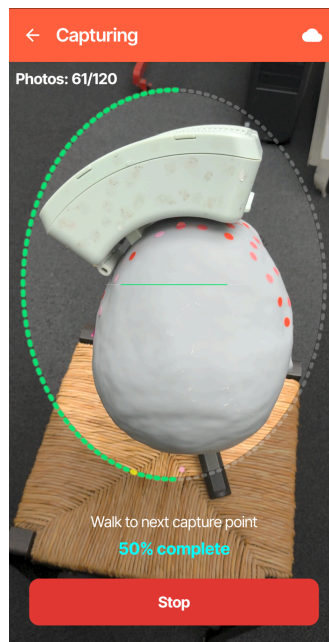


Figure 5: Top view, captured from behind the subject with the phone raised to show the top of the transducer (step 3).

NOTE: An illustrated version of the Recommended Capture Method, showing the walking path and the phone height at each position, is provided in Figure 18.

Running the Open-LIFU Photogrammetry App

The app can be used in Online Mode, which reconstructs the photoscan in the cloud, or in Offline Mode, which reconstructs it locally on the PC. Use Table 1 to choose the workflow that matches your setup, then follow the steps for that workflow below.

NOTE: All images synced with Openwater's Cloud Services are automatically and permanently deleted within 24 hours of being uploaded.

Table 1: Choosing a photogrammetry workflow.

Workflow	When to use	How the photoscan reaches the PC
Option 1 Online Mode: Full Internet Access	You have a Cloud Services account and the PC has internet access.	Reconstructed in the cloud and synced automatically to the Open-LIFU Desktop Application or Slicer Open-LIFU.
Option 2 Online Mode: Limited Internet Access	You have a Cloud Services account, but the PC does not have internet access.	Reconstructed in the cloud and transferred to the PC by USB cable.
Offline Mode	You do not have a Cloud Services account.	The photocollection is transferred to the PC by USB cable and reconstructed locally (requires a GPU).

Online Mode: Cloud Reconstruction

1. Open the application on the phone. Read the Research Device Notice and tap "OK" to accept the terms and conditions. The notice appears each time the app opens unless "Don't show again" is selected.
2. When opening the application for the first time, enable the permissions that are displayed on the screen (photo/video access and location).

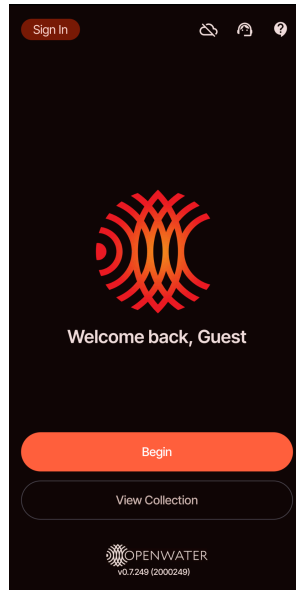


Figure 6: Home screen before signing in. Tap “Sign In” in the top left corner to log into your Cloud Services account (step 3).

3. Tap “Sign In” and log into your Cloud Services account. Accounts are managed by Openwater or a local admin (<https://console.openwater.health/>). For assistance with logging in, contact your local admin or Openwater representative.

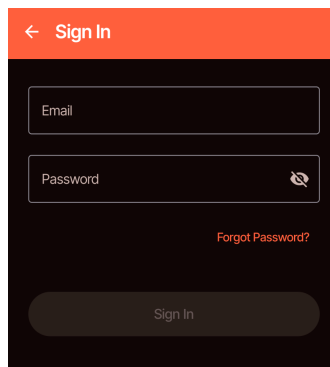


Figure 7: Sign In screen. Enter the email and password for your Cloud Services account (step 3).

4. Once logged in, the Open-LIFU Photogrammetry App will indicate how many user credits are available for scanning (1 credit per scan). Tap “Begin.”

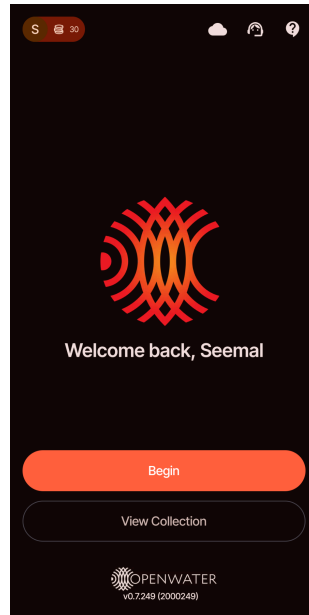


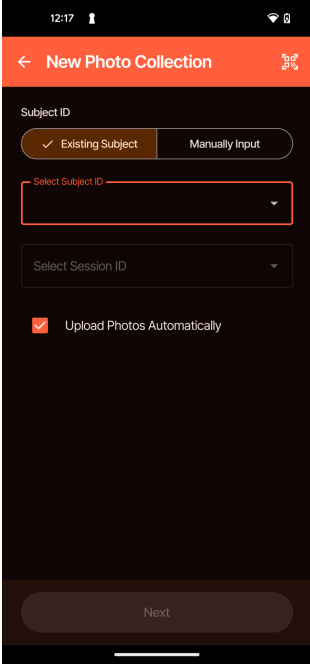
Figure 8: Home screen after signing in. Your name and the number of available credits appear in the top left corner. Click “Begin” to start a new photocollecion (step 4).

5. When you tap “Begin,” you have two options: “Existing Subject” (Option 1) or “Manually Input” (Option 2).

Option 1 Online Mode: Full Internet Access

1. Ensure you are signed in, following the steps from the Online Mode sign-in section. Click “Begin.”
2. Click “Existing Subject.”
3. Choose the subject and session that were selected in the Open-LIFU Desktop Application. These will automatically sync to the Open-LIFU Photogrammetry App for the user to select from.

NOTE: If the Subject or Session ID is not displayed, drag your finger down from the top of the phone screen to refresh the list.



12:17

← New Photo Collection

Subject ID

✓ Existing Subject Manually Input

Select Subject ID

Select Session ID

☒ Upload Photos Automatically

Next

Figure 9: New photocollection screen with “Existing Subject” selected. Select the Subject ID and Session ID that match the session in the Open-LIFU Desktop Application (step 3).

4. Click “Next” to open the capture screen.

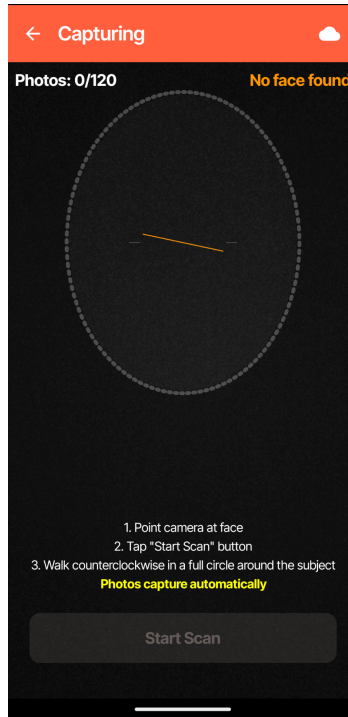


Figure 10: Capture screen before scanning. Point the camera at the subject's face. "Start Scan" becomes available when "Face ready" appears (step 5).

5. Point the camera at the subject's face. When a face is detected ("Face ready" appears at the top of the screen), tap "Start Scan" and walk counterclockwise in a full circle around the subject. Photos are captured automatically.

NOTE: Follow the Photocollection Best Practices when capturing images. The app captures photos automatically and moves to the next screen when all 120 images are captured. "Stop" becomes available after 20 images; stopping early produces a less detailed photoscan, resulting in poor-quality reconstructions. After stopping, tap "Proceed" to keep the images or "Re-capture" to start again.

6. Once scanning is complete, the photoscan will automatically be transferred to the photogrammetry section within the Open-LIFU Desktop Application or Slicer Open-LIFU. Click the "Refresh" button within the application if it does not immediately show up.

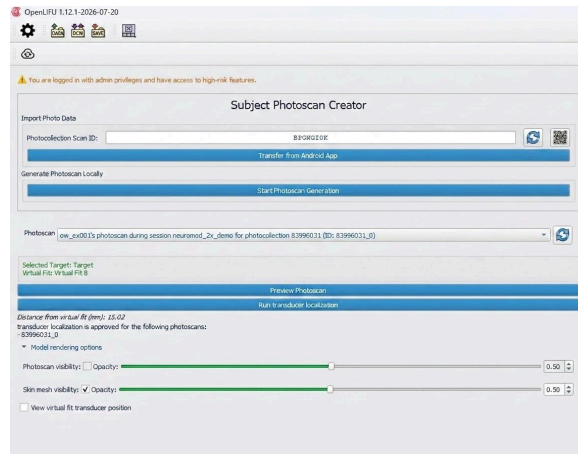


Figure 11: Subject Photoscan Creator in the Open-LIFU Desktop Application. The cloud-reconstructed photoscan appears in the Photoscan list. If it does not appear, click the refresh button (blue double-arrows) beside the list (step 6).

Option 2 Online Mode: Limited Internet Access

NOTE: Manual Input may be used when the PC has no internet access but the user still wants cloud reconstruction. It enables the user to transfer the cloud-reconstructed images directly onto the PC via USB.

1. Ensure you are signed in, following the steps from the Online Mode sign-in section. Click “Begin.”
2. Click “Manually Input.” In the Open-LIFU Desktop Application, navigate to the Subject Photoscan Creator and generate a Subject Scan ID using the blue double-arrows. On the phone, type the ID into the “Input Subject Scan ID” field, or click the QR code icon on the PC and use the Open-LIFU Photogrammetry App to scan the QR code displayed in the desktop application.

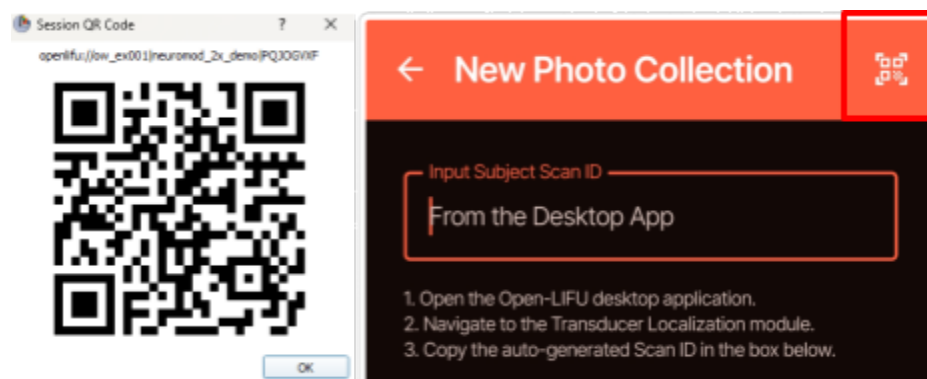


Figure 12: Generating the Subject Scan ID in the Open-LIFU Desktop Application also generates the QR code. Use the blue double-arrows to generate the Photocollection Scan ID, then manually type in the ID or use the QR code icon to display a QR code for the Open-LIFU Photogrammetry App to scan (Online Mode step 2).

3. Click “Next” to begin capturing.

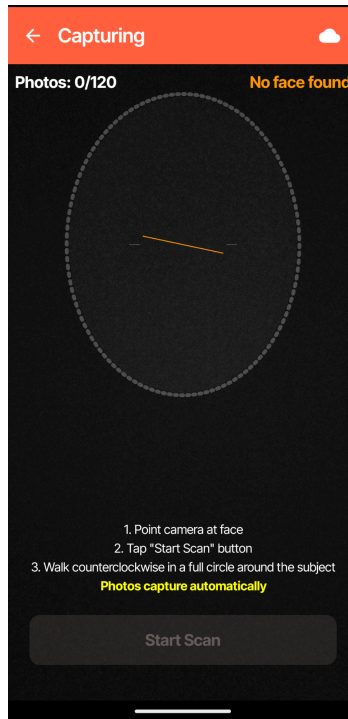


Figure 13: Capture screen before scanning. Point the camera at the subject's face and tap "Start Scan" when "Face ready" appears (step 4).

4. Point the camera at the subject's face. When a face is detected ("Face ready" appears at the top of the screen), tap "Start Scan" and walk counterclockwise in a full circle around the subject. Photos are captured automatically.

NOTE: Follow the Photocollection Best Practices when capturing images. The app captures photos automatically and moves to the next screen when all 120 images are captured. "Stop" becomes available after 20 images; stopping early produces a less detailed photoscan, resulting in poor-quality reconstructions. After stopping, tap "Proceed" to keep the images or "Re-capture" to start again.

5. Once the scan is complete, connect the phone to the PC running the Open-LIFU Desktop Application or Slicer Open-LIFU using a USB-C cable.
6. Click "Transfer to PC" on the phone, then click "Transfer from Android App" in the Open-LIFU Desktop Application. Wait until the phone displays "Status: Completed" and the photocollection appears in the desktop application.

Offline Mode: Local Reconstruction

1. Open the application on the phone. Read the Research Device Notice and tap “OK.” The notice appears each time the app opens unless “Don’t show again” is selected.

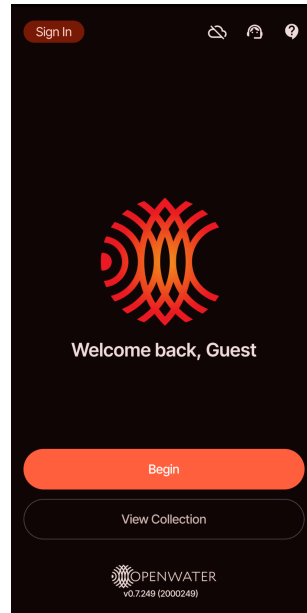


Figure 14: Home screen in Offline Mode. Do not sign in. Click “Begin” to start a new photocollection (step 3).

2. When opening the application for the first time, enable the following permissions while using the application:
 - Photo/video access
 - Location sharing
3. Click “Begin.” **DO NOT** sign in.
4. In the Open-LIFU Desktop Application, open the Transducer Localization module and click the blue double-arrows to generate a new Subject Scan ID. On the phone, type the ID into the “Input Subject Scan ID” field, or click the QR code icon and scan the QR code displayed in the desktop application.

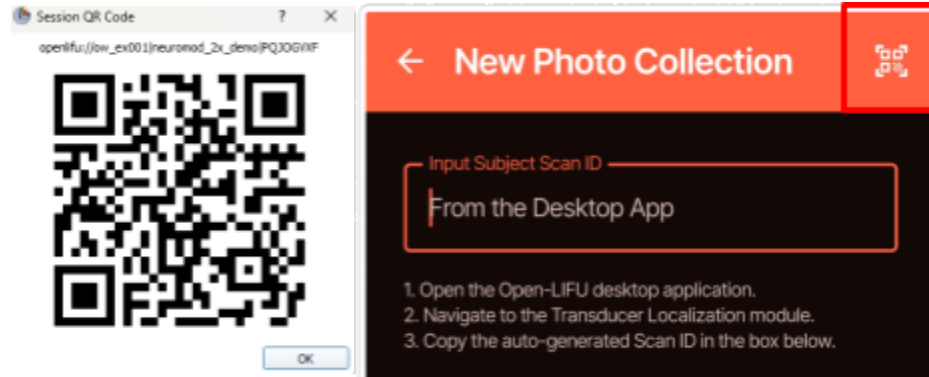


Figure 15: Generating the Subject Scan ID in the Open-LIFU Desktop Application. Use the blue double-arrows to generate the Photocollection Scan ID, then manually type in the ID or use the QR code icon to display a QR code for the Open-LIFU Photogrammetry App to scan (Offline Mode step 4).

5. Click “Next” to begin capturing.
6. Point the camera at the subject’s face. When a face is detected (“Face ready” appears at the top of the screen), tap “Start Scan” and walk counterclockwise in a full circle around the subject. Photos are captured automatically.

NOTE: Follow the Photocollection Best Practices when capturing images. The app captures photos automatically and moves to the next screen when all 120 images are captured. “Stop” becomes available after 20 images; stopping early produces a less detailed photoscan, resulting in poor-quality reconstructions. After stopping, tap “Proceed” to keep the images or “Re-capture” to start again.

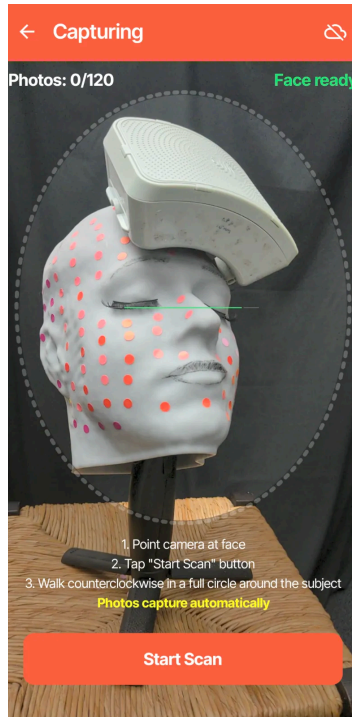


Figure 16: Capture screen before scanning. Point the camera at the subject's face and tap "Start Scan" when "Face ready" appears (step 6).

7. Once the scan is complete, connect the phone to the PC running the Open-LIFU Desktop Application or Slicer Open-LIFU using a USB-C cable.
8. Click "Transfer to PC" on the phone, then click "Transfer from Android App" in the Open-LIFU Desktop Application. Wait until the phone displays "Status: Completed" and the photocollection appears in the desktop application.
9. Use the desktop application to reconstruct the 3D mesh.

For Offline Mode, the following settings are recommended prior to starting reconstruction:

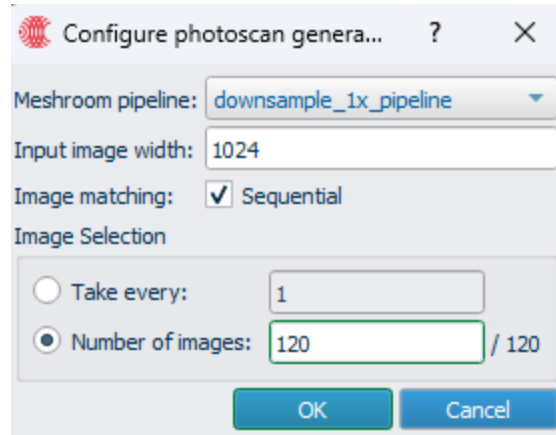


Figure 17: Recommended Offline Mode settings in the “Configure photostan generation” window: Meshroom pipeline “downsample_1x_pipeline,” input image width 1024, Sequential image matching, and 120 images.

Viewing and Managing Photocollections

Photocollections remain on the phone after capture. Use “View Collection” to review, transfer, or delete them.

1. On the home screen, tap “View Collection.” Each photocollection is listed by its Subject Scan ID, with the capture date and the number of photos.
2. Click a photocollection to open it. If the photostan has not been processed (“Scan Not Processed”), tap “Transfer to PC” to transfer the photocollection to the PC by USB cable.
3. Click “Photos” to scroll through the captured images. To delete individual images, select them and tap “Delete.”
4. To delete the entire photocollection, tap the three-dot menu in the top right corner and select “Delete Scan.”

Customer Support

For help with the Open-LIFU Photogrammetry App, contact Openwater Support using the information below or the details provided in your Service Agreement.

✉: support@openwater.cc

☎: (415) 484-3776

🌐: www.openwater.health

From the app, tap the Customer Support icon (headset) on the home screen to email, call, or visit the Openwater website. Click the Support & Legal icon (question mark) to watch the video tutorial, submit feedback, or view the Research Device Notice.

Troubleshooting

Table 2: Common troubleshooting issues, potential causes, and recommended steps.

Issue	Potential cause	Recommended steps
Slow photogrammetric reconstruction	PC is underpowered	Use the Online Mode to generate the photoscan
	The Open-LIFU Photogrammetry App is outdated	Visit the Google Play Store and update to the latest version of the Open-LIFU Photogrammetry App
Cannot connect to the Open-LIFU Photogrammetry App (Offline)	- Cable not properly connected - Faulty cable - Incompatible drivers - Computer antivirus blocks access	Inspect connection cables, verify drivers, and allow application access through network and security settings
	- ADB not installed - Environment variables are not set properly	- Navigate to the Login page and confirm ADB has a green checkmark next to it - If not, click on the button to install it
Cannot connect to the Open-LIFU Photogrammetry App (Online)	Not signed into Openwater's Cloud Services on both devices	Ensure you are signed into both devices with the same Cloud Services account
	Not signed into Openwater's Cloud Services on both devices with the same Cloud Services account	
	Cloud account does not exist	Ensure you have an active Cloud Services account
	The Open-LIFU Photogrammetry App is outdated	Visit the Google Play Store and update to the latest version of the Open-LIFU Photogrammetry App

Issue	Potential cause	Recommended steps
	Unstable or no network connection	- Check network connection - Connect to a different network - Contact your IT department or network provider if the problem persists
The Open-LIFU application is not synchronizing with the Open-LIFU Photogrammetry App (Online)	Not signed into Openwater's Cloud Services on both devices with the same Cloud Services account	Ensure you are signed into both devices with the same Cloud Services account
	Cloud account does not exist	Ensure you have an active Cloud Services account
	Unstable or no network connection	- Check network connection - Connect to a different network - Contact your IT department or network provider if the problem persists
Photocollections are not synchronizing from the Open-LIFU Photogrammetry App to the cloud	Not signed into Openwater's Cloud Services on the Open-LIFU Photogrammetry App	Ensure you are signed into the Open-LIFU Photogrammetry App with the same Cloud Services account
	Cloud account does not exist	Ensure you have an active Cloud Services account
	Cloud reconstruction credits have been exhausted	Contact Openwater Support
	The Open-LIFU Photogrammetry App is outdated	Visit the Google Play Store and update to the latest version of the Open-LIFU Photogrammetry App

Issue	Potential cause	Recommended steps
	Unstable or no network connection	- Check network connection - Connect to a different network - Contact your IT department or network provider if the problem persists
Slow system performance	- No/incompatible graphics card - Graphics card not functioning - Too many programs, apps, or background processes running simultaneously	- Use the recommended GPU and ensure drivers are up to date - Close all other programs and apps before running Open-LIFU
Poor image reconstruction	- Low-quality photocollection - The background in the photos may be too "busy"	- Ensure the Open-LIFU Photogrammetry App is up to date - Follow the best practices for capturing images
	Phone held too far away from the subject's head/face	Adjust closeness/camera position relative to subject
Poor photogrammetry registration with the MRI	Low-quality image reconstruction (photoscan)	Ensure the Open-LIFU Photogrammetry App is up to date
	Selected anatomical landmarks or features between the 3D mesh and MRI do not match	Accurately select corresponding anatomical landmarks or features on both the 3D mesh and MRI

Issue	Potential cause	Recommended steps
Open-LIFU transducer shifts on the subject's body after the photogrammetry mesh has been acquired	• The transducer was not properly secured to the subject • The transducer was accidentally bumped	• Adjust the transducer straps to firmly hold it in place on the subject and recapture the photogrammetry mesh • If necessary, adjust the transducer, then recapture the photogrammetry mesh and repeat session planning • Ensure subject is sitting in a comfortable position where their movement is minimal
"No face found" or "Move closer" appears during capture	• The subject's face is not inside the on-screen oval • The phone is too far from the subject	• Point the camera at the subject's face and move closer until "Face ready" appears • Fill as much of the oval as possible with the subject's head and the transducer

Appendix

Sine Wave Capture Method

This appendix illustrates the Recommended Capture Method described in the Photogrammetry Workflow section. Walk counterclockwise around the subject while moving the phone up and down in a “sine wave.”

Recommended Capture Method

Walk counterclockwise around the subject while moving the phone up and down in a “sine wave.”

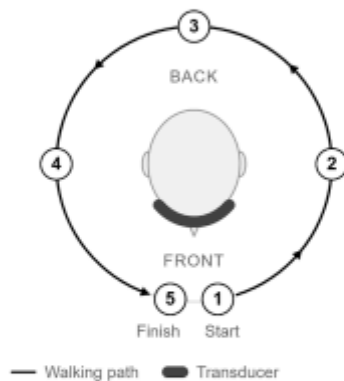


Before you start

Recline the subject: Have the subject lean back at a slight angle in a reclining chair or against a neckrest.

Start at the front: Before you begin capture, hold the phone facing the front of the subject.

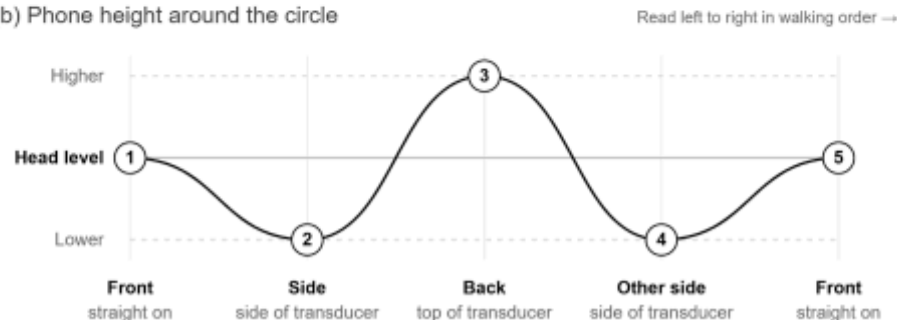
(a) Walking path, viewed from above



Steps

- ① **Start at the front**
Hold the phone straight on, level with the subject's head.
- ② **Lower the phone toward the side**
Lower the phone gradually as you walk to the side to capture the full side of the transducer.
- ③ **Raise the phone at the back**
Raise the phone as you reach the back to capture the top of the transducer. Reclining the subject makes this easier.
- ④ **Lower the phone toward the other side**
Lower the phone again until you have a full side view of the transducer.
- ⑤ **Return to the front**
Raise the phone back to straight on as you walk back to where you started.

(b) Phone height around the circle



This process captures the front, side, and top views of the transducer and ensures complete coverage of the head and transducer from various angles.

Figure 18: Sine wave capture method, showing the counterclockwise walking path around the subject and the phone height at each position.