3DMakerpro Eagle Max Handheld LiDAR Scanner

SLOlab Quick Start Guide

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Useful Links

- **Eagle User Guide (Online Version)**
- **RayStudio Download Page**
- **CloudCompare Download Page**
- **Blender Download Page**
- **“3DMakerpro Eagle Lidar Scanner User Group”** is an active Facebook Group for Eagle users and an excellent resource for examples, workflows, and peer support. 3DMakerpro themselves are one of the group admins. For issues not addressed in this guide or the official user manual, consider posing your questions there.
- **BAGEL** is a browser-based viewer for ROSBAG files that runs on-device without any file upload. Highly useful for reviewing and understanding the *.bag files that the Eagle generates.

A Brief Intro to LiDAR

LiDAR (***Li**ght **D**etection **a**nd **R**anging,* or ***L**aser **I**maging, **D**etection, **a**nd **R**anging*) is a spatial scanning technology that rapidly bounces a laser onto surrounding objects to calculate a point cloud representation of a real-world space. It is often used in land surveying, automation (e.g. self-driving cars), and architectural contexts.

LiDAR is particularly effective at capturing **larger-scale objects and environments**; for smaller single objects, photogrammetry tools or all-in-one scanners specialized for small models tend to be more successful. Keep this in mind when considering your particular use case.

Intro to the 3DMakerpro Eagle Max

The 3DMakerpro Eagle Max is an all-in-one handheld LiDAR scanner.

Like many other all-in-one LiDAR scanners, it is comprised of:

- **A LiDAR module** (in this case, the Livox Mid-360), for capturing sweeps of depth data at a regular interval.
- **An IMU sensor,** for capturing the scanner’s orientation and trajectory during a scan. This allows the sweeps of depth data to be ‘solved’ into a static three-dimensional form.
- **Cameras** (in this case, four 48 MP fisheye cameras), which capture photographs over the course of a scan in order to colourize the resulting point cloud during processing.

- **A GPS module**, for writing location and compass orientation metadata to the point cloud.

The Eagle outputs its raw data as ***.bag** files, also known as ROSBAG files. These are timestamped recordings of topics and messages (similar to MQTT) taken from the Eagle's various sensors over the course of a scan.

- The **LIDAR_*.bag** file contains each frame of the LiDAR module's sweeps, as well as the IMU sensor's various readouts.
- The **IMAGE_*.bag** file contains four channels of image sequences, one for each of the Eagle Max's cameras.
- The **GPS_*.bag** file records the latitude, longitude, and altitude of the scanner.

Scanning

Before you start

According to its product page, the Eagle Max has a reported point cloud frequency of 200,000 points per second. Ensure that you are using an adequately high-speed, high-capacity microSD card for your scanning work. The Eagle Max comes with a 128 GB U3 microSD card. Cards should be formatted as **exFAT (cross-platform)** or **NTFS (Windows-only)**; this can be done directly from the Eagle Max's settings screen under **Storage** after the card has been inserted.

As a courtesy to other users of the scanner, please delete your scans after transferring them from the device.

Performing a scan

1. Power on the Eagle Max by pressing the **On / Off** button located just below its screen.
2. Tap **Scan**.
3. Under **Project Name**, enter a name for your scan; this will become the name of the scan folder, making it easier to identify later.
4. Under **Camera Settings**, you can keep the default selection of all cameras enabled and framerates set to medium.
    - High framerates are primarily recommended if you intend to explore RayStudio's Gaussian splatting capabilities, but will lead to greater disk usage by your scans.
5. Under **GPS**, **Connect GPS** if desired.

- When enabled, the Eagle attempts to connect with GPS satellites to encode your scan with UTM coordinates and improve its adherence to real-world compass orientation. Unless you know you won't need this, there is no harm in enabling it for the extra metadata. *Note: GPS connectivity tends to be difficult to establish indoors and may only work reliably for outdoor scans.*
- As an advanced use case, the Eagle Max can be used with an RTK setup for increased positional accuracy.

6. When ready, tap the button at the bottom of the screen to proceed. Depending on whether **Connect GPS** was enabled, the screen will now either **check the system time** or **attempt to connect to GPS satellites**. Once this process is complete, another button will appear at the bottom of the screen; tap to proceed.
7. The scan will begin immediately. Per the on-screen instructions, **hold the scanner level and still for approximately 5 seconds before moving with it**; this is to establish a baseline reading for the IMU sensor that processing software can reference later.
8. **Walk slowly around the environment you intend to capture, pointing the scanner toward all objects and surfaces you wish to include.** Points are added continuously over time, so the more time you spend focusing on a particular region, the denser and more detailed that region will become in the final cloud.
    - Keeping the scanner level throughout is the recommended use according to official 3DMakerpro documentation, though gently swinging the scanner upwards and downwards tends to improve colour data capture on higher objects (while sometimes introducing some sky/ceiling-based colour artifacts on edges). If in doubt, try both to see what works best for your particular use case.
9. When finished, tap the button at the bottom of the Eagle's screen to conclude the scan. A low-resolution preview will be displayed for quick review.

Data Transfer

There are three methods of transferring scans from the Eagle Max to a PC for post-processing. In order from fastest to slowest, they are:

1. Direct copy from microSD card.
2. Transfer via network hotspot.
3. Transfer via USB drive.

Note that methods 2 and 3 require the Eagle to be powered on during transfer. Its external power supply can (and likely should) be connected during this process to prevent unexpected shutdowns and corrupted transfers.

Direct copy from microSD Card

Prerequisites: Hex (i.e. Allen) key, computer with microSD card slot or adapter.

If still attached, detach the handle from the base of the Eagle Max. Its quick release plate should still be attached to the scanner. In order to access the microSD card, this plate must be removed.

Use a hex key to remove the black screw from the quick release plate, then hand-remove the remaining silver screw. Gently lift the grey rubber cover from the microSD card slot and press down on the card to spring-release it.

Insert the card in any computer and open it via a file explorer. You can now find and retrieve your scans with a simple copy-and-paste. Be sure to copy the entire folder of each desired scan to avoid leaving behind any auxiliary files necessary for post-processing.

Transfer via network hotspot

Prerequisites: Computer with Wi-Fi capability and 3DMakerpro RayStudio installed.

On the Eagle Max, open the Settings menu, then navigate to **Hotspot Links** and toggle **“Activate hotspot.”** When enabled, the scanner starts broadcasting its own Wi-Fi access point with the following credentials:

SSID: Rayzoom G100

Password: 12345678

From a PC with **RayStudio** installed on it, **connect to this new Wi-Fi network.**

Open **RayStudio**, then in the bottom-left corner of the main window, click **Transmission**.

In the top-left panel, change **Location** to the target directory on your PC where you would like your LiDAR files to be transferred. Keep **Hostname** set to “192.168.1.5,” **Username** set to “forlinx,” and **Password** set to “forlinx,” as these values are (currently) hard-coded within the Eagle Max’s firmware.

Click the **Connect** button in the bottom-left corner. If successful, the main window should now be populated with a list of all scans currently stored on the Eagle Max. To transfer a scan, hover over its list item and click the **download icon** that appears at the rightmost end of the row.

Scans can be transferred in parallel; simply click the download icon on each to begin the transfer.

Transfer bandwidth has been measured at roughly **10 MB/s.**

Once all desired transfers have completed, click **Project List** (top-left corner of the window) to return to the main RayStudio screen, then click **Open Project** (bottom-left), navigate to the directory of one of your transferred scans, and click **Open** to open it for post-processing.

Transfer via USB drive

Prerequisites: External USB storage device, USB-A to USB-C adapter (optional), PC with relevant USB port.

Insert a USB-C storage device, or a USB-A storage device connected to a USB-C adapter, into the **Data port** of the LiDAR scanner, located to the right of the Power (charging) port just below the battery indicator.

On the Eagle Max, tap the **pencil icon** on the top-right of a particular scan's thumbnail, then tap **Export** on the menu that appears to begin transferring the data to the connected storage device.

Batch transfers can be initiated by tapping the **list icon** at the top-right of the Eagle Max's main screen. Simply **tap each scan you wish to transfer** to select it, then tap the **export icon** on the bottom-right to begin the transfer.

Once all desired transfers have completed, remove the external storage device, connect it to your post-processing PC, and move/copy project folders from the device as you would any standard file or folder.

Processing via RayStudio

Scans captured with the Eagle Max are originally captured as *.bag files and require processing via 3DMakerpro's proprietary RayStudio software before they can be exported to a file format compatible with other tools like CloudCompare, TouchDesigner, or Blender.

See Useful Links for a download link to the latest version of RayStudio.

RayStudio is currently only available for Windows, though it has been found to run without issue on Linux through a Wine compatibility layer. A similar approach may work on macOS.

This section assumes you have already transferred your scans from the Eagle Max; if not, see Data Transfer for instructions.

From the main RayStudio window, click **Open Project** (bottom-left corner). Navigate to the scan folder you wish to process, then click **Open**.

To begin, click the **Data Processing** button at the bottom of the window.

1. Under **Scene Type**, select **Indoor**, **Outdoor**, or **Stairwell** to reflect your scan content.

2. Enable **Coloring** if a full-colour point cloud is desired.
3. Enable **Automatic Closed Loop** to compensate for any IMU drift during longer scans.
4. Enable **Filter Type** to detect and remove noise (i.e. outlier points) from the scan. Adjust strength to taste, or keep the default of **Medium**.
5. Enable **Thining** [sic] **Mode** to automatically downsample regions of the point cloud determined by RayStudio to be overly dense compared to others.
6. Enable **RTK Calibration** to apply GPS data (if captured at the time of scanning) to the resulting point cloud. If enabled, keep the default setting of **WGS84** and leave the optional **RTK file directory** and **GEOID file** fields blank.
7. Press **Start**.

Once processing is completed, RayStudio's window will update to display the resulting point cloud. Click and drag to rotate the cloud. Scroll to adjust zoom.

Display settings such as background, point size, and EDL shading (Eye-Dome Lighting) can be adjusted via the **Property** pane (top-right corner).

The **Data Management** pane (bottom-right corner) can be used to export the processed cloud to formats amenable to other software, including LAS, PCD, and PLY. Simply click to select the point cloud you wish to export from the list (for example, "color.amap" for a colourized point cloud), click the **export icon** (open rectangle with arrow pointing right, at the top of this pane), then save the file in a directory of your choosing.

Alternatively, after running data processing, the scan folder itself will be populated by a number of files that can immediately be opened in point cloud software like **CloudCompare.**

Look for:

- ./recalculate_result.pcd
- ./process_result.las
- ./filter_result.las
- ./shading/all_color.pcd
- ./shading/rtk_all_color.las
- ./shading/rtk_fixed.pcd

Next Steps

CloudCompare

CloudCompare (see Useful Links for download link) is a free and open source point cloud software that enables a plethora of post-processing workflows including but not limited to:

- Advanced noise filtration
- Cross-sectioning
- Cropping/trimming
- Aligning and registering multiple point clouds
- Tree isolation

CloudCompare also offers a greater selection of export formats than RayStudio.

Blender

Blender (see Useful Links for download link) is a free and open source 3D modelling and rendering software. For LiDAR workflows, it can be used to create high-quality renders and creative distortions of your point clouds, as well as to export them to formats like FBX and glTF, which can then be imported to game engines (e.g. Unity, Unreal Engine, Godot) and web viewers (e.g. Three.js).

Note that you will likely need to export your point cloud as a PLY file using RayStudio or CloudCompare first, then import it to Blender via **File / Import / Stanford PLY (.ply)**.