Automated Terrestrial Lidar Acquisition System (ATLAS)

Hardware Build

Model Orion (v1.0.0)

Document Last Updated: 2026/01/07

Overview

This document outlines a procedure to build a low-cost 3D scanner using commercial-off-the-shelf (COTS) components. Because components change, this is a living, evolving document that will attempt to encompass the current state-of-the-art (SOTA) sensors and algorithms.

The scanner output dataset can be used directly into reconstruction libraries such as Colmap or Glomap and the colored point clouds, images, and poses can be used to do further refinement such as registration, dense reconstruction, Gaussian splatting, and even object detection.

The skill level in order to build these hardware configurations will vary in complexity from simple bolt screwing, to electrical wire stripping (no solder required). Also note that there are a few **optional** steps that may require the need to drill mounting holes in the metal enclosure and heat heat-shrink tubing for the wiring.

There are several configurations contained in this document that can be built to suit various use-cases. Also, you will find most components are interchangeable, making the system highly configurable and applicable to a wide range of use-cases. This includes a basic rigid-mount sensor configuration, a fully stand-alone mobile scanner system, and auxiliary equipment to help simplify the setup and ease of use.

The **rigid-mount configuration** allows builders to retrofit the combined sensor pack onto an already existing scanner system or test the provided software repo without investing in the enclosure hardware (see figure 1). In this basic configuration, it can be used for experimental setups by connecting the lidar and 360 degree camera to power and a computer.

Figure 1: MODE A, Basic Rigid-Mount Sensor Pack Configuration

The **stand-alone scanner configuration** features battery power and compute needed to operate the scanner for a few hours (see figure 2). The battery can then be recharged or swapped out for a new one when needed. The computer used in this setup is a Linux Ubuntu computer capable of a wide range of tasks since it contains quad 3.4GHz CPU, 16GB RAM, Intel UHD Graphics, and 0.5TB of storage. For example, I tested Half-life Deathmatch multi-player game and was impressed with the performance. :-)

Figure 2: MODE B, Stand-alone Mobile Scanner Configuration

Optional auxiliary components in this guide include a professional tripod, camera harness, Pelican carrying case, and a custom cable harness. The extended, custom cable can be used to connect the stand-alone scanner to power and external devices such as a monitor and USB devices. The hardware build of each of these configurations are detailed below.

MODE A (Sensor) and B (Scanner) Required Setup

Bill of Material (BOM) Required for All Modes

Modes:

Sensor – basic, rigid-mount sensor setup
Scanner – full, stand-alone mobile 3D scanner (includes Sensor Mode)
Aux – optional, auxiliary, or development equipment

Mode	Function	Component	Description	Cost
Sensor/Scanner	Lidar	Livox Mid360	10cm-70m viewing distance, accuracy ≤2cm@10m, ≤3cm@0.2m	$900
Sensor/Scanner	Spherical Camera	Insta360 One X2	5.7k 360 video camera, USB-C	$230
Sensor/Scanner	Sensor Mount	Cheese Plate (Bracket)	Cheese Plate/Bar with Multiple Threaded Holes	$10
Sensor/Scanner	Hardware Fastener	Rubber Washers	Rubber Washers with 1/4" Screw Hole	$6
Sensor/Scanner	Cable	RCA to Screw Terminal Adapter	Male RCA Plug to Screw Terminal Connector Adapter	$5
Sensor/Scanner	Cable	DC Power Adapter Cable	DC 5.5 x 2.1mm Female to 8mm RCA Male Power	$9

			Cable	
Sensor/Scanner	Build Material	Electrical Tape	¾” black electrical tape, roll	$4
Sensor/Scanner	Build Material (optional)	Heavy Duty Gaffer Tape	Non-reflective, black, 2”x30 yards	$20
Sensor/Scanner	Build Material (optional)	Heat Shrink Tubing Kit	Black Heat Shrink Tube Wire Shrink Wrap Shrinkage Ratio 2:1	$10
Sensor/Scanner	Build Material (optional)	Cordless Heat Gun	600 degrees F, Fast Heating, Rechargeable Mini Hot Air Gun	$26
				$1220 total

Note: *See the Mode B section of this document for a full list of components needed to build a Mode B scanner.*

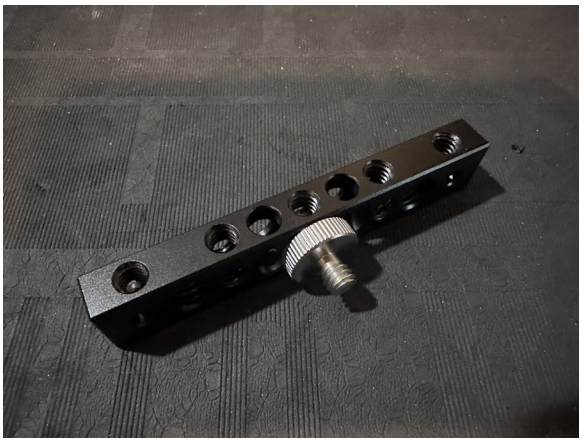
Assembly Instructions: Mode A/B

Mode A/B, Step 1

Gather the cheese plate, double screw (1/4”-20, included with cheese plate), 360 camera, and (2) rubber washers for next steps.

Mode A/B, Step 2

Assemble the cheese plate and double screw as below. Ensure the double screw is tight to the bracket using pliers.



Mode A/B, Step 3

Assemble the (2) rubber washers onto the bracket assembly as below.

Mode A/B, Step 4

Assemble the camera onto the bracket assembly. Ensure to properly match the orientation below. The camera should be tightly screwed onto the base, ensuring the camera is approximately 90 degrees relative to the bar horizontally.

Mode A/B, Step 5

Gather the lidar interface cable (should be included with lidar), RCA to terminal connector, and heat shrink tubing (optional) for the next steps. Tools needed include a screwdriver, wire strippers, and a heat gun (optional).

Mode A/B, Step 6

Locate the multi-colored cable in the lidar interface cable bundle. This will have 5 wires in it. If using heat shrink, cut a piece about 2” long of the tubing.

Mode A/B, Step 7

Trim the multi-colored wires so they are staggered and at different heights.

Mode A/B, Step 8

Place the heat shrink over the trimmed wires and heat (optional). If not using heat shrink, use electrical tape to cover the wires. We won’t be using these wires in this assembly. Instead we will use the Ethernet and power cable (black/red wires) to connect the lidar to a computer.

Mode A/B, Step 9

Gather the power cable (black/red wires from the lidar interface cable), RCA to terminal connector, and heat shrink (optional) for the next steps.

Mode A/B, Step 10

Trim the red and black wires so there is 1” of wire. Use wire strippers to strip the wire covering back ¼” leaving copper exposed. If using 1” dia. heat shrink, be sure to place it on the power cable.

Mode A/B, Step 11

Attach the black and red wires to the screw terminals of the connector. The red wire goes to positive (+) and the black wire goes to negative terminal (-). Be sure the wires are completely in the terminal before screwing down. Ensure the screws are tightly securing the cable. If using heat shrink, apply heat to the tubing. Otherwise use electrical tape or gaffer tape to cover the wires.

Now the sensors are ready to be connected to power and communication. To assemble the basic sensor mount Mode A, see below. Otherwise skip to the Mode B section.

MODE A: Basic Rigid-Mount Sensor Configuration

(without Power or Compute, follow MODE B for stand-alone scanner)

Assembly Instructions: Mode A (continued from Mode A/B, Step 11)

Mode A, Step 12

Gather the camera bracket assembly, lidar, and (2) M3x20 screws, (2) M3 lock washers, and (2) M3 flat washers

Mode A, Step 13

Attach the lidar onto the camera bracket assembly using the set of screws and washers. Ensure to properly line up the holes to properly attach the bracket to the lidar. The lidar should be tightly fastened onto the base, ensuring the proper orientation below.

Mode A, Completion

The sensors can now be calibrated together and used in the software portion of this repo. Use a USB-C cable to connect the camera to a computer. For the lidar, use the

included interface cable to connect the lidar to a computer Ethernet port and power. For power, connect the RCA male connector to your connector of choice, but the 5mm size is common for DC power connections. You can use the bracket in any configuration as long as the sensors are rigidly mounted in the configuration above or use it to mount to another system.

MODE B: Full Scanner Build *(with Power and Compute Module)*

Bill of Material (BOM) for Mode B Scanner

Modes:

Sensor – basic, rigid-mount sensor setup
Scanner – full, stand-alone mobile 3D scanner (includes Sensor Mode)
Aux – optional, auxiliary, or development equipment

Mode	Function	Component	Description	Cost
***See Additional Sensor Parts needed above				$1220
Scanner	Compute	Mini PC (sub1)	16GB DDR4 RAM, 512 GB SSD, 3.4GHz, 4 cores, Intel UHD graphics, original model	$249
Scanner	Scanner Monitor	Mini Touchscreen Monitor	7", 1024 X 600 Small HDMI Monitor HDMI Portable LCD	$54

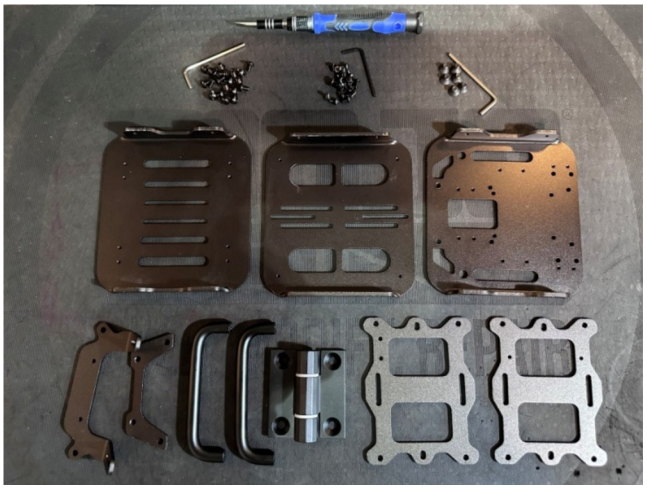
			Monitor,VESA 75x75	
Scanner	Battery Power	Power Bank	24000mAh, 88Wh	$60
Scanner	Hardware Fixture	Scanner Bracket Assembly	With mounting hardware	$442
Scanner	Hardware Fixture	Camera Mount	1/4"-20 Thread & Mounting Slots	$11
Scanner	Hardware Fixture	Camera Tripod	Light-weight Carbon fiber, 11lb load tolerance,	$122
Scanner	Hardware Fixture	Foam Tubing	3/8" Black Foam Tubing Handle Grips, 3.3ft long	$8
Scanner	Hardware Fastener	Camera Thumbscrew	Stainless Steel D Shaft D-Ring 1/4" Tripod Screw	$7
Scanner	Cable	1’ Angled HDMI Cable	Flat Slim High Speed HDMI Male to Male Extension Cable 90 Degree Down Angle (1 Feet) Adapter Converter Cable	$6
Scanner	Cable	1’ Angled USB Cable	10Gbps USB 3.1 Gen 2 USB A to USB C Data Transfer Braided Cord, Right Angle	$10
Scanner	Cable	Short USB C Cable	4 inch Flat Dual USB C Cable Right Angle	$7
Scanner	Cable	Short, Right Angle DC Power Splitter Cable	5.5mm x 2.1mm Male to Double RCA Female Cable	$10
Scanner	Cable	DC Power Adapter	90 Degree Right Angle 2.5mm x 5.5mm Male Plug to 2.1mm x 5.5mm Female Jack Coupler Converter	$9
Scanner	Cable	DC Power	5.5mm x 2.1mm,	$6

		Connector Adapter	Male to Male Power Jack Barrel Plug	
Scanner	Cable	USB A to USB C Adapter	USB C Female to USB Male 3.1, SuperSpeed Data Sync & 100W	$7
Scanner	Build Material	Cable Straps	Hook and Loop Fastening Cable Straps and Cable Ties Set (8"-12"-18"	$9
Scanner	Build Material	Small Zip Ties	4” black, weather resistant	$8
Scanner	Build Material	Medium Zip Ties	8” black, UV resistant	$8
				$2253 total

Assembly Instructions: Mode B (continued from Mode A/B, Step 11)

Mode B, Step 12 (continued)

Gather the scanner hardware to be used for the next steps



Mode B, Step 13 (optional)

Optional: Measure the mounting holes on the mini-computer in order to drill and mount onto the scanner. If you want to avoid drilling into metal, you can use hook and loop straps instead to secure the computer onto the scanner (explained in step 17). For the computer below, the holes were M3 and approx. 1 1/4” apart and 3/8” from the top.

Mode B, Step 14 (optional)

Optional: Using the measurements from above, mark the holes on the compute rack mount to be drilled.

Mode B, Step 15 (optional)

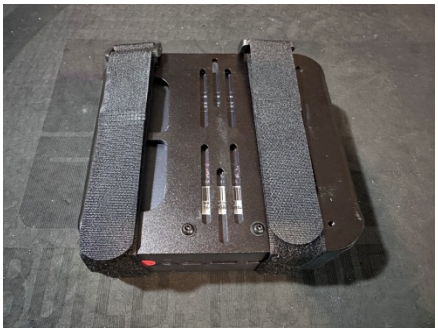
Optional: Drill the holes on the compute rack mount for the mini computer. Since the screws needed were M3, I drilled 4mm holes.

Mode B, Step 16 (optional)

Optional: Mount the mini computer onto the compute rack mount using (2) M3x8 screws with M3 washers.

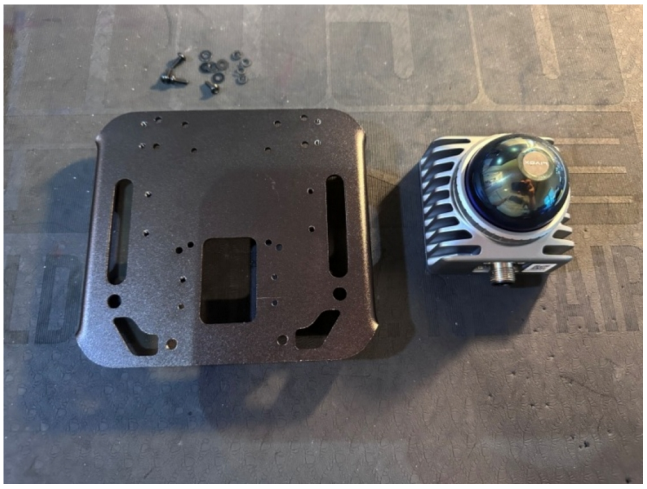
Mode B, Step 17

If not mounting the mini computer with screws, use hook and loop tape to attach the computer to the shelf. Use (2) 18” hook and loop straps to attach the mini computer to the compute rack mount securely. Ensure the straps are placed similar to below so the ports and power button can still be accessed.



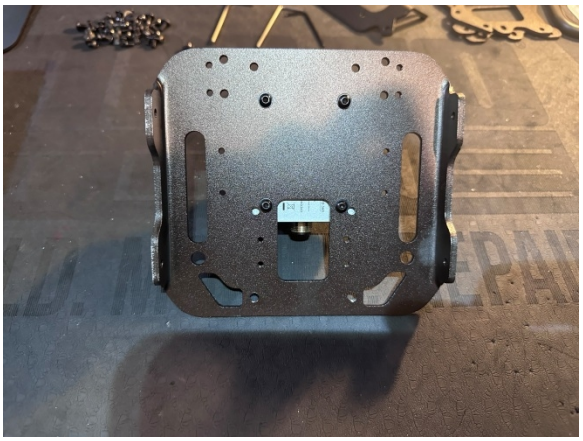
Mode B, Step 18

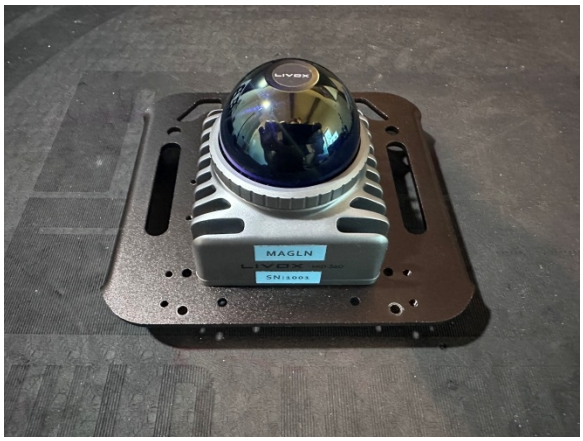
Gather the lidar, mounting rack, and hardware [(4) M3x12 screws, M3 flat washer, and M3 lock washer] for the next steps.



Mode B, Step 19

Mount the lidar onto the rack mount using the (4) M3x12 screws, M3 flat washer, and M3 lock washer. Be sure to securely fasten the lidar onto the mount using the configuration below.



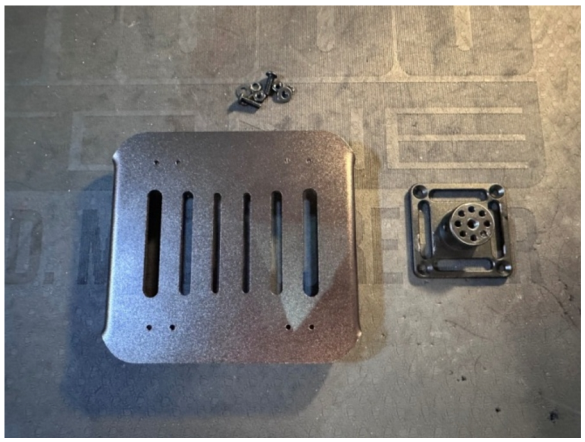


Mode B, Step 20

Mount the camera mount assembly onto the lidar rack mount using (2) M3x20 and M3 nuts. Be sure to securely fasten the mount using the configuration below.

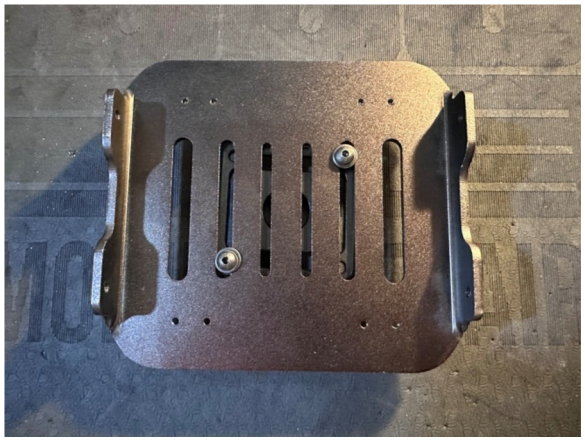
Mode B, Step 21

Gather the bottom rack mount, camera mount, and hardware [(2) M4x12 screws, (2) M4 nuts, (2) M4 flat washers, (2) M5 flat washers] for the next steps.



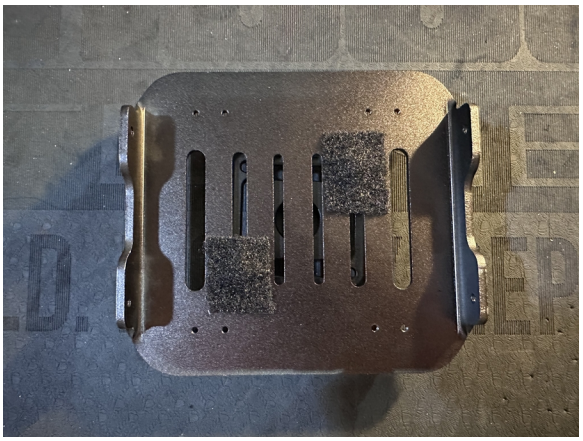
Mode B, Step 22

Mount the camera bracket onto the bottom of the rack mount using (2) M4x12 screws, (2) M4 nuts, (2) M4 flat washers, and (2) M5 flat washers. Be sure to securely fasten the bracket in the configuration below.



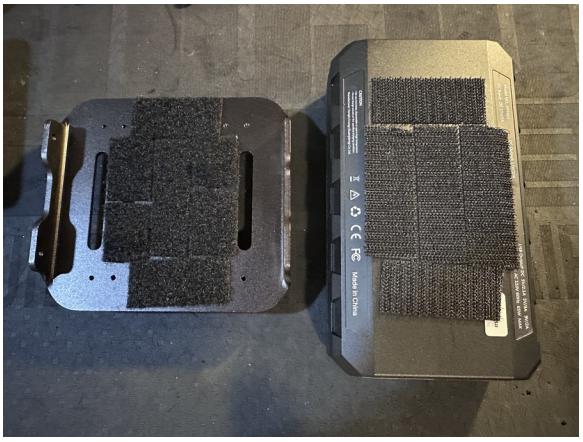
Mode B, Step 23

Place one side of hook and loop tape or electrical tape over both of the screw heads on the power mount rack. This will prevent any physical damage the screw might have on the power bank enclosure.



Mode B, Step 24

Cut hook and loop tape as below and adhere them to both the bottom of the power bank and the top of the power mount rack. Place one side of hook and loop tape or electrical tape over both of the screw heads. This will prevent any physical damage the screw might have on the power bank enclosure.

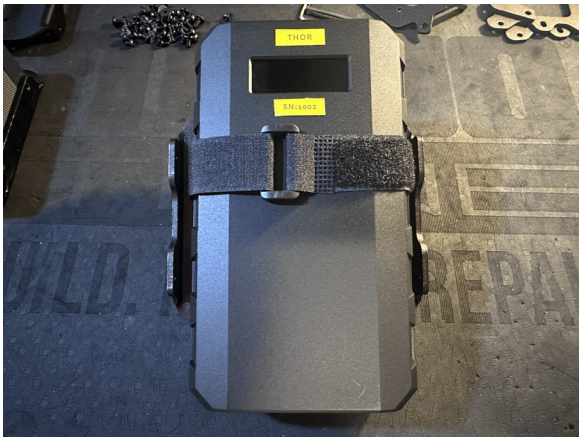


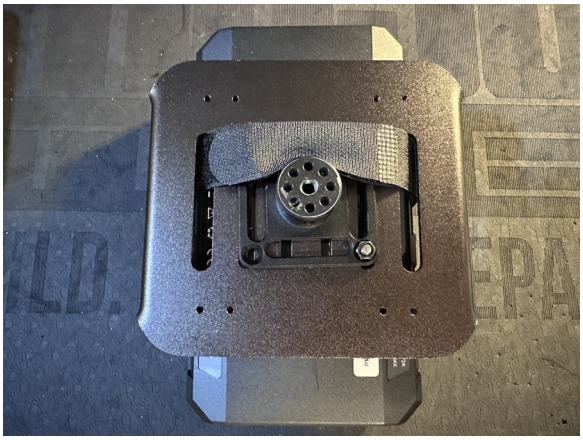
Mode B, Step 25

Attach the power bank to the power mount rack using the hook and loop tape. Be sure to attach in the configuration below.

Mode B, Step 26

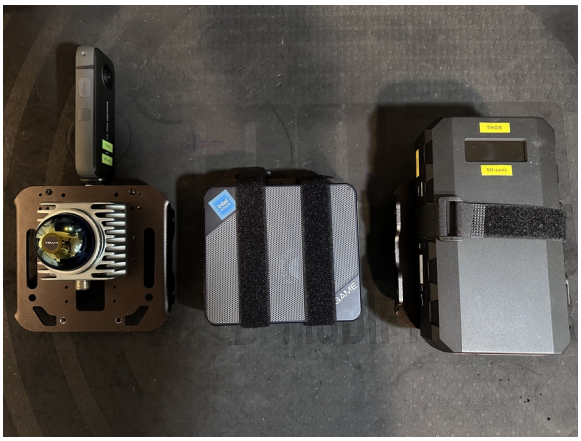
Use a 18” hook and loop strap to secure the power bank around the shelf. Ensure to pull the slack tight and to attach the end of the strap as below.





Mode B, Step 27

Now the sensor rack (top), compute rack (middle), and power rack (bottom) sub-assemblies are complete and ready to be combined in the next steps. Gather (12) M4x8 screws and M4 flat washers.



Mode B, Step 28

Combine the compute rack (middle) with the scanner side panels using (4) M4x8 screws and (4) M4 flat washers. Ensure the computer shelf is mounted as far up as possible in the adjustment slots.

Mode B, Step 29

Gather the handles and foam tubing for the next steps.

Mode B, Step 30

Cut the foam tube into (2) 4 ¼” long pieces.

Mode B, Step 31

Attach the (2) previously cut foam tubes onto the grip handles. You may need to twist and wiggle the foam tube onto the metal handle.

Mode B, Step 32

Now the grip handles are ready to be fastened to the side panels.

Mode B, Step 33

Attach the grip handles to the side panels using (4) M4x8 screws and (4) M4 flat washers. Be sure to securely tighten the screws.

Mode B, Step 34

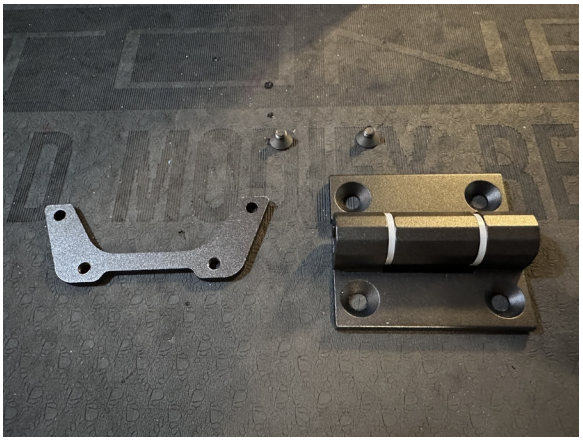
Attach the power bank shelf to the side panels using (4) M4x8 screws and (4) M4 flat washers. Be sure to follow the configuration below and securely tighten the screws.

Mode B, Step 35

Attach the sensor shelf to the side panels using (4) M4x8 screws and (4) M4 flat washers. Be sure to follow the configuration below and securely tighten the screws.

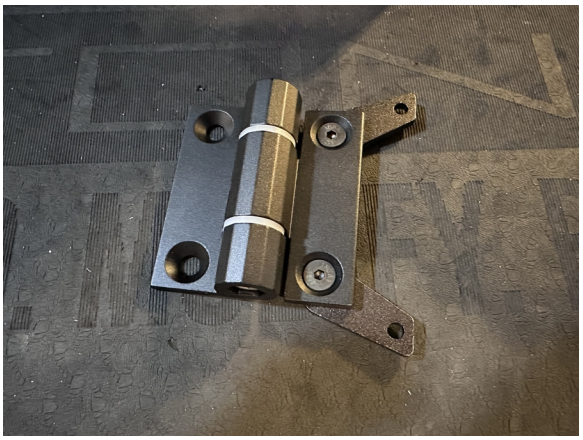
Mode B, Step 36

Gather the display hardware that was included with the scanner brackets. (2) M5x6 flat head screws were used.



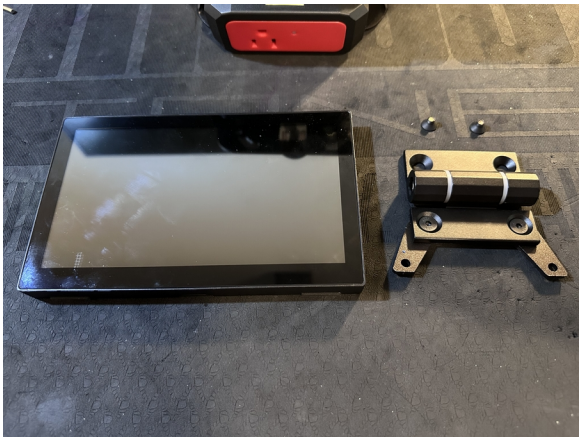
Mode B, Step 37

Securely fasten the display bracket onto the hinge using the (2) M5x6 flat head screws.



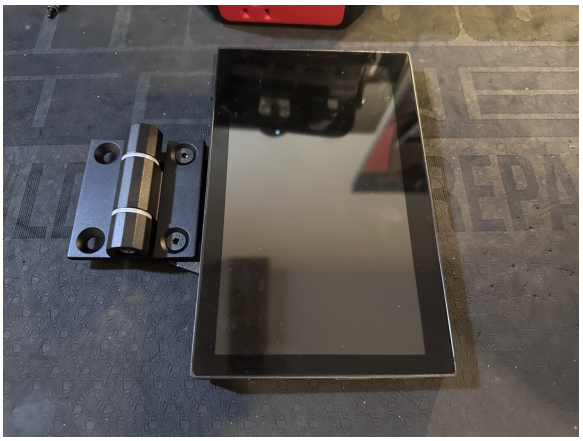
Mode B, Step 38

Gather the display and display mount assembly hardware for the next steps.



Mode B, Step 39

Securely fasten the display mount to the display using the (2) M4x8 screws and (2) M4 flat washers

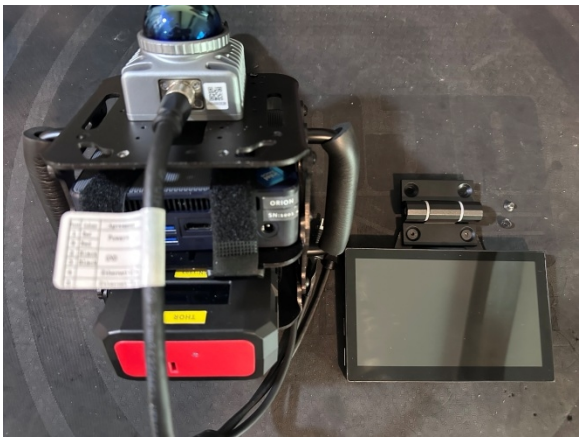


Mode B, Step 40

Mount the lidar interface cable onto the lidar by screwing the outside ring.

Mode B, Step 41

Mount the display on the scanner assembly by bending the lidar interface cable behind the display mount hinge. Securely fasten the display mount to the scanner assembly using (2) M5x6 flat head screws ensuring to keep the configuration below.



Mode B, Step 42

Gather(3) 4” small zip ties, the short USB and HDMI angled cables for the display.

Mode B, Step 43

Attach the display cables together with small zip ties arranged similar to below. You can trim the excess leads from the zip ties.

Mode B, Step 44

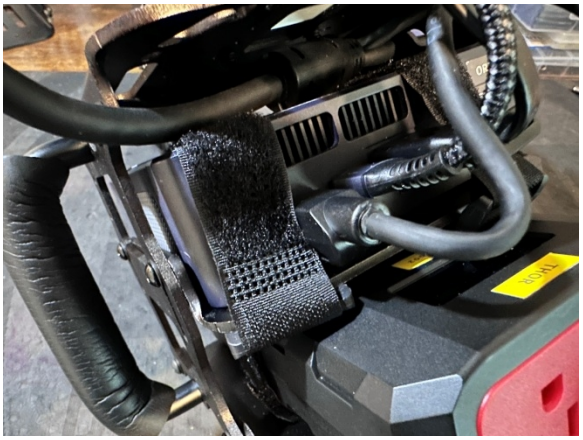
Connect the angled display cables to the scanner display.

Mode B, Step 45

Pull the display up towards the lidar and attach the display cables to the mini computer.

Mode B, Step 46

Connect the lidar Ethernet cable to the back of the mini computer.



Mode B, Step 47

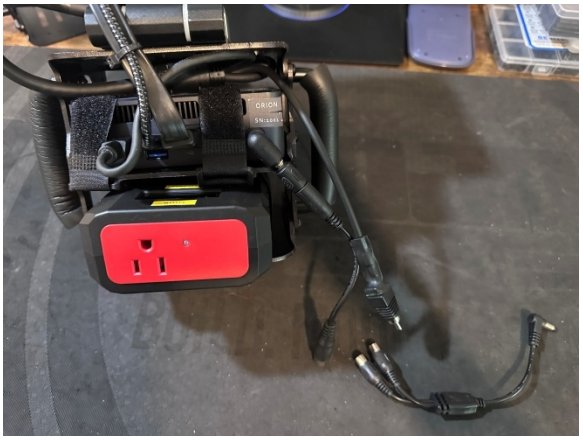
Gather the DC power cables for the power cable assembly.

Mode B, Step 48

Connect the bottom barrel cable assembly together like below.

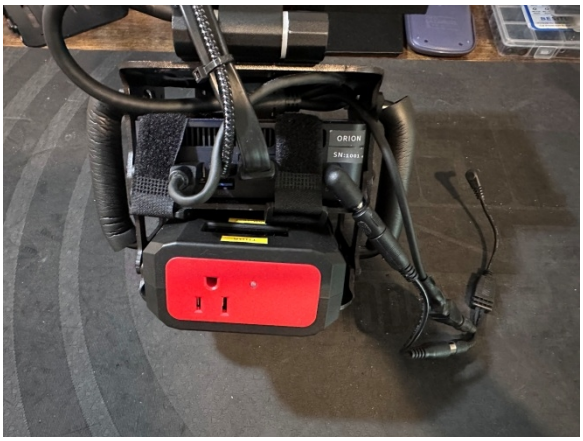
Mode B, Step 49

Connect the angled barrel connector of the power cable assembly into the mini computer power input.



Mode B, Step 50

Now connect the RCA cables together on the power cable assembly. You can use electrical tape or gaffer tape to ensure the cables stay connected together.



Mode B, Step 51

Adjust the cabling so it will hide between the sensor rack and the compute rack. Ensure the output barrel connector it left out so we connect it in next steps.

Mode B, Step 52

Insert the barrel power connector into the power bank input.

Mode B, Step 53

Gather the scanner assembly, small angled USB-C cable and USB-C to USB-B adapter.

Mode B, Step 54

Connect the USB-C cable to the camera and scanner by using the configuration below. Ensure the USB port is USB 3.0 compatible.

Mode B, Completion

Now the scanner can be powered on by following these directions:

1. On the power bank, hold the power button for three seconds
2. Press the mini-computer power button to turn on the computer
3. Press the camera power button to turn on the camera
4. Press the display power button to turn on the display

Auxiliary Equipment

Bill of Material (BOM) for Accessories and Dev

Modes:
Sensor – basic, rigid-mount sensor setup
Scanner – full, stand-alone mobile 3D scanner (includes Sensor Mode)
Aux – optional, auxiliary, or development equipment

Mode	Function	Component	Description	Cost
Aux	Accessory	Mini Multi-Color Cable Labels	Colorful Wire Labels w/ Hook and Loop	$16
Aux	Accessory	Premium Inkjet Printer Vinyl Sticker Paper	Self-Adhesive Sheets Matte White Waterproof, Tear Resistant	$12
Aux	Accessory	Camera Harness	Dual Camera Carrier Chest Harness, Double Shoulder Camera Strap	$40
Aux	Accessory	Pelican Case	8”x8”x14”, w/ foam, retractable handle and wheels	$280

Aux	Development	27” LED Monitor	75 Hz, 1080P HDMI	$90
Aux	Development	Mouse	USB Wired Mouse	$8
Aux	Development	Keyboard	Wired, Full-Size	$12
Aux	Development	Mouse Pad	Full-Size	$10
Aux	Development	USB Hub	0.7’, 4 Ports with 5Gbps Data Transfer, Multiple USB 3.0 Hub, USB Splitter, no charging	$10
Aux	Development	Ethernet to USB Adapter	USB-3.0, gigabit	$12
Aux	Development	HDMI Coupler Cable Adapter	HDMI Female to Female Connector Adapter 3D 4K 1080P HDMI Cable Extender	$14
Aux	Development	USB Extension Cable	10’ Male to Female Cord High Data Transfer	$6
Aux	Development	HDMI Cable	10’ Male to Male Cable	$6
Aux	Development	Power Strip with 15' Cable	6-Outlet Power Strip Surge Protector, 15FT Long Extension Cord, Low Profile Flat Plug, 15 Amp Circuit Breaker	$18
Aux	Development	Black Cable Clips w/ Adhesive	Self-adhesive black cable clips for desk	$10
				$544 total

Assembly Instructions: Aux Equipment

Long custom cable for external communication and power

A 15’ custom cable can be built in order to connect the stand-alone scanner to power or communication (e.g. USB/HDMI).

Lay the cables out and bunch them together into groups using small zip ties or gaffer tape like below. You will have a group of cables for USB/HDMI to external devices and another group of cables that will connect to the scanner that include HDMI, USB, and power cables for both the lidar and computer. The power strip will need to plug into an electrical output.

Tip: Use cable labels to help properly identify each cable and where it goes. Feel free to zip tie the power bricks to the power strip so they stay connected.