emesent

# SPOT CAGE FOR HOVERMAP USER MANUAL

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## Using this manual

Hovermap is a powerful system that can be used as a LiDAR mapping payload, but also as an advanced autopilot for drones and other platforms. We therefore recommended that you read the user manual thoroughly to make use of all its capabilities in a safe and productive way.

## Disclaimer and safety guidelines

This product is *not* a toy and must not be used by any person under the age of 18. It must be operated with caution, common sense, and in accordance with the instructions in the user manual. Failure to operate it in a safe and responsible manner could result in product loss or injury.

By using this product, you hereby agree that you are solely responsible for your own conduct while using it, and for any consequences thereof. You also agree to use this product only for purposes that are in accordance with all applicable laws, rules and regulations.

The use of Remotely Piloted Aircraft Systems (RPAS) may result in serious injury, death, or property damage if operated without proper training and due care. Before using an RPAS, you must ensure that you are suitably qualified, have received all necessary training, and read all relevant instructions, including the user manual. When using an RPAS, you must adopt safe practices and procedures at all times.

## Warnings

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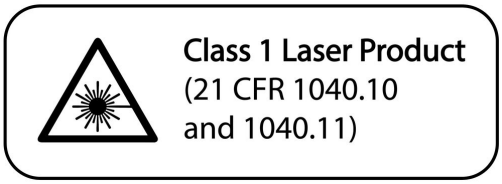
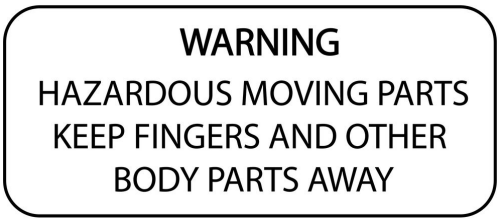
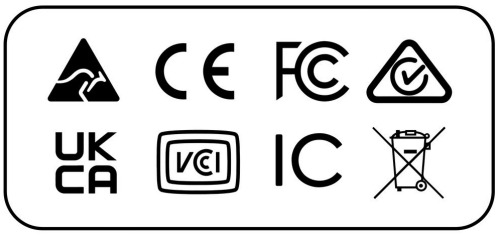
- Do not attempt to disassemble, repair, tamper with, or modify the this product. This product contains no user-serviceable parts inside. Any disassembly of the product enclosure will invalidate the IP65 rating and disrupt the factory calibration of LiDAR. Contact Emesent for any repairs or modifications.

- Always be aware of moving objects that may cause serious injury, such as spinning propellers or other components. *Never* approach a drone while the propellers are spinning or attempt to catch an airborne drone.



# Contents

# 1. Overview

The **Spot Cage for Hovermap** is a versatile accessory designed to provide a secure and functional solution for mounting the Hovermap on your Spot robot to perform mapping missions.

> ⚠ The Spot Cage is shipped with two plastic packaging bumpers to protect the cage and packaging during transport.
> Before using the Spot Cage, carefully remove both of these plastic bumpers to ensure they do not interfere with Hovermap's sensors.

Below are the key features and benefits of the Spot Cage.

**Robust Protection:** The enclosure is engineered to safeguard the Hovermap in the event of a fall from a standing position.

**Reduced Blind Spots:** The enclosure is strategically designed to minimize blind spots in Hovermap scans, enabling more comprehensive and accurate mapping results.

**Compact Design:** The enclosure adds minimal width and height to your Spot Robot, ensuring it remains agile and efficient.

**Vibration Isolation System:** Equipped with a vibration isolation system, the enclosure enables precise point cloud creation comparable to handheld scans.

**Electrical & Data Connection:** The enclosure provides a seamless electrical and data connection, allowing you to power your Hovermap directly from the Spot battery via the General Expansion Payload (GXP). This feature also facilitates future data offloading via the Spot dock.

**Space Efficiency:** The enclosure allows you to mount additional sensors on your Spot robot, such as CAM, CAM+, CAM+IR, CORE I/O, EAP2, gas, noise, vibration, RBD/thermal images, and more, without compromising functionality.

**Extended Operation:** With the Spot Cage, you can capture data for the entire duration of your Spot robot's battery life without sacrificing map quality.

# 2. Specifications

- **Weight**
  - 5.9 kg
- **Dimensions**
  - 400L x 190W x 280H mm [2 3/16 x 3 5/32 x 6 1/8 in]
- **Robot Mount**
  - Forward mounted on Spot using the payload rail system + Spot Arm mounting points

> **Note**
> The Spot Cage cannot be mounted at the same time as the Spot Arm as they are not compatible.

- **Hovermap Compatibility**
  - Hovermap ST
  - Hovermap ST-X
- **Long Range Radio Compatibility**
  - Yes (optional)
    2.4 GHz / 915 MHz antenna mounting kits are available to mount antennas externally on Spot Cage for maximum range
  - Antenna kits include an adaptor plate to allow mounting of Long Range Radio Groundside to the Spot UXV Controller
  - If a colorization mount is attached to the Long Range Radio Airside, it must be removed before mounting the Hovermap into the Spot Cage

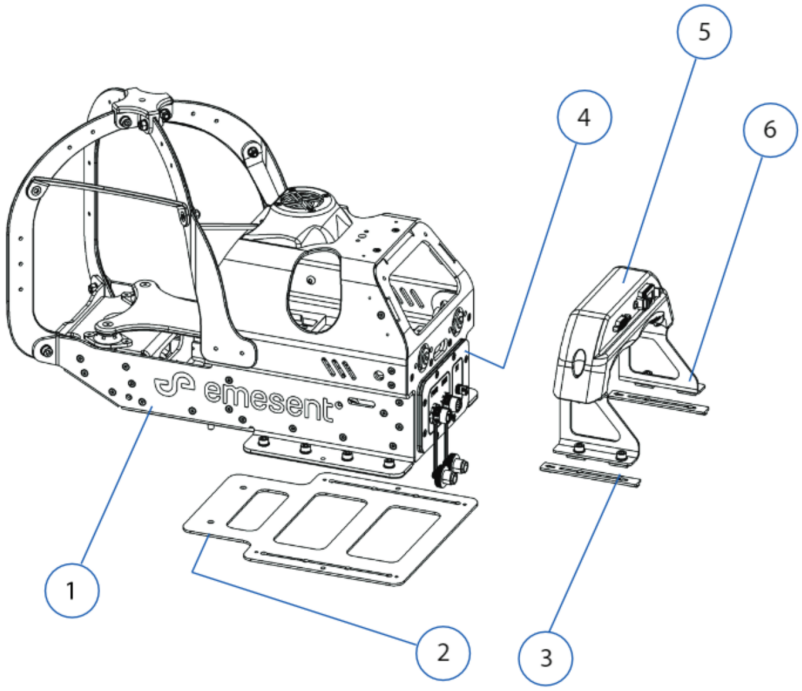
> **Note**
> Spot Cage is not compatible with Long Range Radio Colorization.

- **Power**
  - M12 terminated cable included for connection to Spot GXP HD15 port for regulated 24V supply
  - Hovermap power cable included for connection between Spot Cage and the Hovermap ST/ ST-X
- **Materials**
  - **Spot Cage**
    - 5052 aluminum sheet metal parts
    - 6061-T6 aluminum machined parts
    - 316 stainless steel ribs (powder coated)
    - Nylon PA6 / Nylon 12 electronics enclosure
    - 304 stainless steel fasteners (black oxide coated)
    - ABS/PC-like polyurethane resin with glass fiber fill fan shroud
    - PLA fan shroud bolt sleeves
  - **GXP Riser**
    - 304 stainless steel sheet metal
    - 304 stainless steel fasteners

# 3. Software Requirements

- **Hovermap Software:** version 3.1 or later
- **Spot Firmware:** version 3.3.x

# 4. What's in the Box




1. Spot Cage
2. Spot Cage Alignment Plate
3. GXP Riser Alignment Jig
4. Spot Electrical Interface
5. Spot GXP (not included/sold separately)
6. GXP Riser

**Included Tools and Cable**

- Spot GXP power cable M12-D15 300mm
- Spot Ethernet cable M12-RJ45 300mm
- Power & data cable for Hovermap ST/ST-X 350mm
- 2mm Hex Short Arm Wrench / 4mm Hex Short Arm Wrench

# 5. Additional Parts Required

- Boston Dynamics General Expansion Payload (GXP) - sold separately

# 6. Optional Extras

- Spot Long Range Radio Antenna Kit - 915MHz
- Spot Long Range Radio Antenna Kit - 2.4GHz

# 7. Tools Required

- 2mm Hex Short Arm Wrench (provided)
- 4mm Hex Short Arm Wrench (provided)
- 8mm Spanner or Adjustable Wrench (for GXP Riser installation - not provided)

# 8. Installing the Spot Cage

1. Remove any T-slot nuts in the payload rails that might block the installation of the cage.
2. Remove the alignment plate from the bottom of the cage as shipped and set aside the attached M5 screws, washers, and T-slot nuts for later use.
3. Remove the two (2) rear M5 socket head screws from the arm mount at the front of the robot's body.

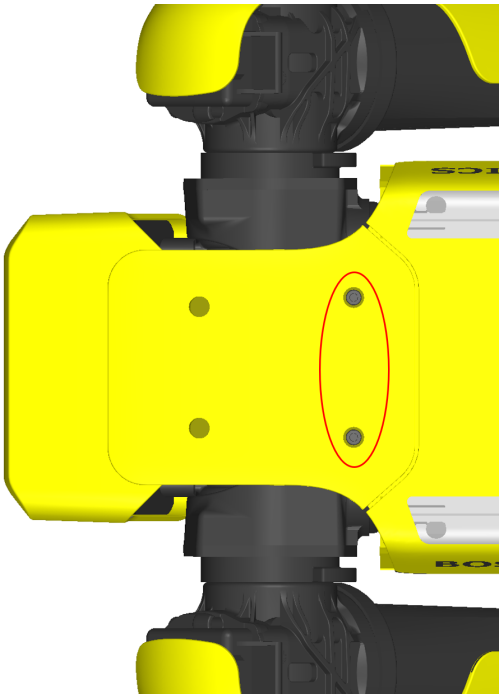


**Figure 1 M5 screws to remove from the arm mount**

4. Insert four (4) T-slot nuts into each payload rail, totalling eight nuts for each rail on the robot.

5. Install the alignment plate onto the robot using the two (2) M5 socket head screws as shown. This will serve as a reference point for accurately positioning all T-slot nuts within the payload rails.


**Figure 2 Alignment plate attachment to Spot**

6. Position the T-slot nuts in the payload rails to match the cut-outs on the alignment plate. Use the elongated slot and a 2mm Hex Key to slide them into position. Secure each nut in place by threading an M5 cap head screw, ensuring that they are properly aligned with the designated holes.
7. Secure the eight (8) T-slot nuts by tightening the set screws using a 2mm Hex Key.

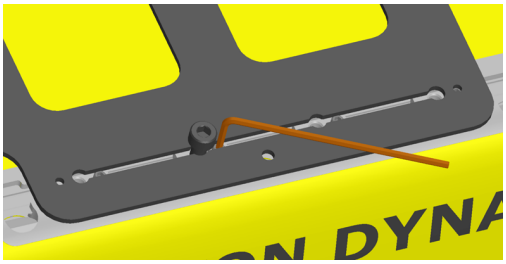


**Figure 3 T-slot nut alignment and set screw tightening**

8. Remove the alignment plate by unfastening the two (2) front M5 screws.
9. Position the cage on top of the robot and align the screw holes on the cage with the set T-slot nuts in the payload rails.
10. Secure the cage to the robot by fastening the ten (10) M5 screws as follows, with one (1) M5 washer underneath the head of each screw:

a. Insert eight (8) M5x10 screws with washer through the cage mounting flanges and into the T-Slot nuts in the payload rails.

b. Insert two (2) M5x20 screws with washer through the front of the cage and into the arm mounting holes.

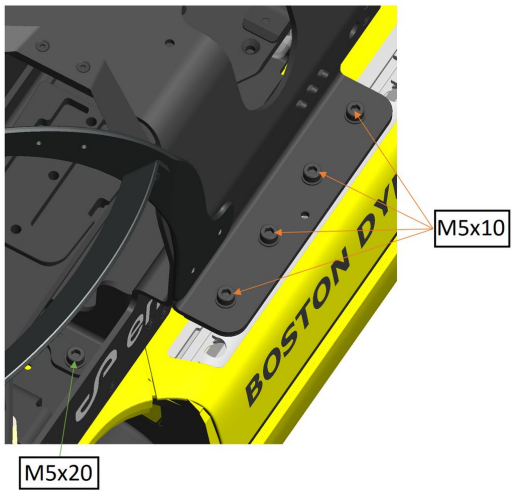



**Figure 4 Cage attachment bolt positions**

11. If a Long Range Radio will be used, install it to the Hovermap using the defined installation procedure.

12. Secure the Hovermap payload by sliding the Hovermap onto the dovetail in the cage.


**Figure 5 Hovermap insertion**

13. Install the GXP in one of two ways:
    If you intend to attach a rear-mounted Boston Dynamics payload along with the Spot Cage, follow the installation instructions for the GXP riser assembly (outlined below).
    -or-
    Otherwise, proceed to install the GXP using two (2) T-slot nuts and two (2) M5x16 screws. Place the GXP behind the central connector port with the connectors facing backward.

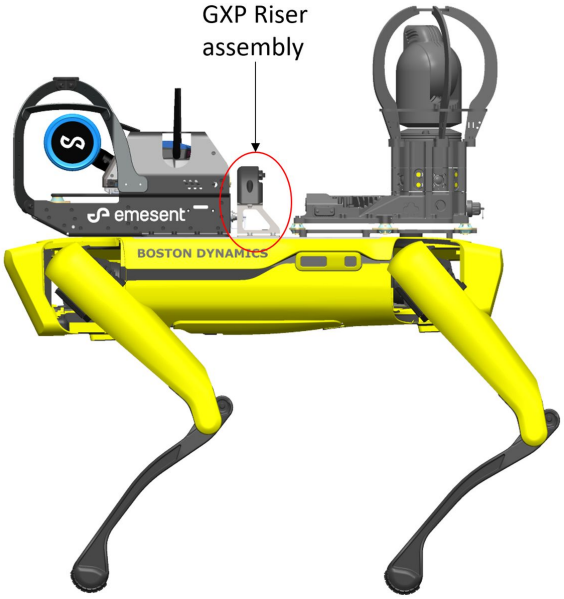

**Figure 6 GXP position for when rear-mounted payloads are not required**

15. Connect the Hovermap to the Spot Cage using the Fischer to Fischer cable provided. Connect one end to the back panel of the Hovermap and the other end to the Fischer port labeled ST on the back of the Spot Cage.
16. Connect the Spot Cage Power to the GXP DB15 connector using the M12 to HD15 cable provided. Once connected, make sure that the screw connector is securely fastened to avoid intermittent failures.
17. Connect the Spot Cage Ethernet to the GXP Ethernet port using the M12 to Ethernet cable provided. Once connected, make sure that the screw connector is securely fastened to avoid intermittent failures.

> **Note**
> If the M12 to Ethernet cable that connects the Spot Cage to the GXP Riser gets disconnected while in use, you will need to power cycle both Spot and the Hovermap payload after reconnecting the cable to re-establish the network connection.

# 9. GXP Riser (Optional)

To support additional rear-mounted payloads (e.g., Spot CAM/EAP2), a GXP Riser will be required to provide additional mounting capacity. The GXP Riser should be installed after the Spot Cage is properly fitted.




## 9.1 Parts Required

- Emesent GXP Riser Kit
- Boston Dynamics GXP **with Shielded Ribbon Cable**

## 9.2 Installing the GXP Riser

1. Remove the front payload port cover if you haven't already done so. If you have previously attached a GXP to that port, remove it. Keep the cover in a secure location.
2. Attach the left and right risers onto the GXP unit first using two (2) M5x20 bolts, along with washers and flange nuts. To fasten the bolt effectively, you'll need an 8mm spanner or an adjustable wrench to grip the flange nut. The risers should concave inwards, and the sloped edges should be on the same side as the GXP connectors - which designates the rear side.

**Figure 7 GXP attachment to the risers**

3. Insert two (2) T-slot nuts in each payload rail (4 total) using the rear cut-out in the payload mounting rail.
4. Use the GXP Nut Alignment jig to position the T-slot nuts correctly. Place the GXP Nut Alignment Tool against the cage, within the payload rail channel, ensuring that the arrow points toward the cage or front of the robot.

5. Secure the four (4) T-slot nuts in place using the 2mm Hex Key.

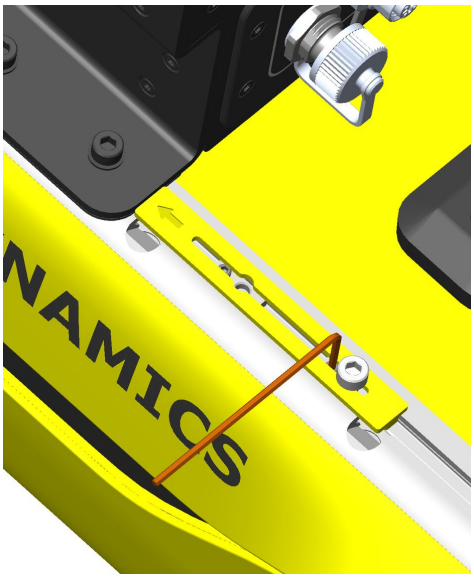



**Figure 8 T-slot nut alignment and set screw tightening**

6. Mount the risers to the payload rails using four (4) M5x8 screws.

**Figure 9 Riser attachment to the payload rails**

7. Attach and fasten the ribbon cable to the bottom of the GXP and the robot's front payload port.

# 10. Long Range Radio Antenna Extension Kit (Optional)

The Long Range Radio (LRR) Antenna Extension Kit allows antennas to be mounted at the back of the Spot Cage providing a greater communication range compared to the standard antenna mount location.

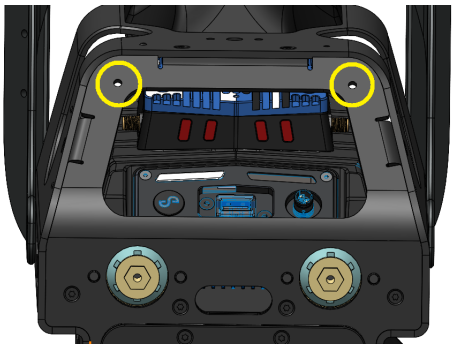
> **Note**
> A bracket is included in the kit to allow the Groundside LRR to be mounted at the back of the Spot UXV Controller.

> **Note**
> Two antenna kits are available for the LRR - one for the 915MHz and the other for the 2.4GHz ISM radio band. It is important to use an LRR Antenna Extension Kit that matches the frequency band of your LRR hardware. If you use a kit with a different frequency band, it will reduce the communication range.

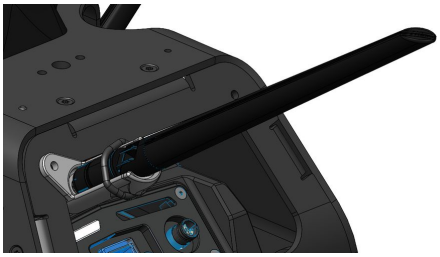
## 10.1 Installing the Antenna

1. Make sure to fully tighten each antenna into the SMA connector of the antenna support elbow and secure it with the supplied o-ring.

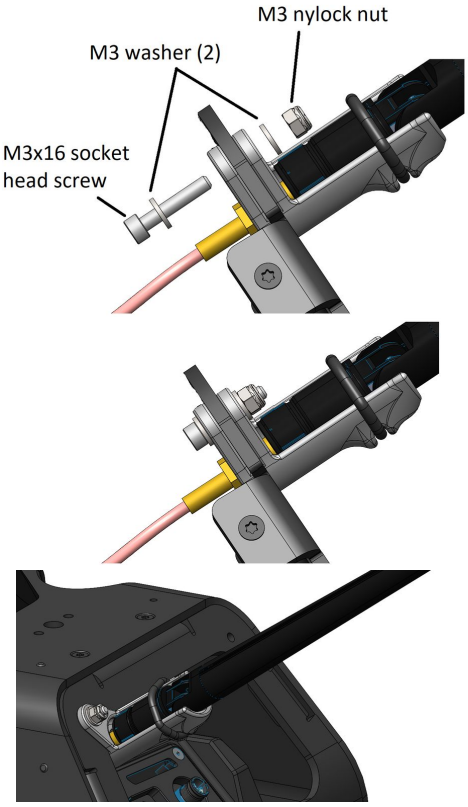
2. Locate the two antenna extension mount holes on the rear of the cage.



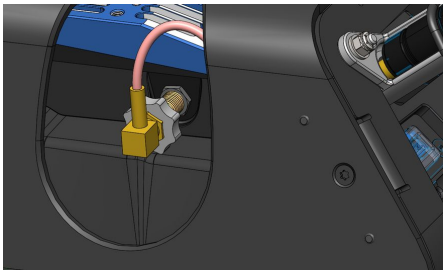
3. Slide the left-hand elbow support (“L” and “R” are embossed on the inner face) into place on the left-hand side of the rear cage panel until the mounting holes align.



4. Push an M3x16 socket head screw with an M3 washer placed under the screw head through the elbow support mounting flange. Secure it in place with an M3 washer and M3 nylock nut. Tighten until the elbow support material slightly compresses.



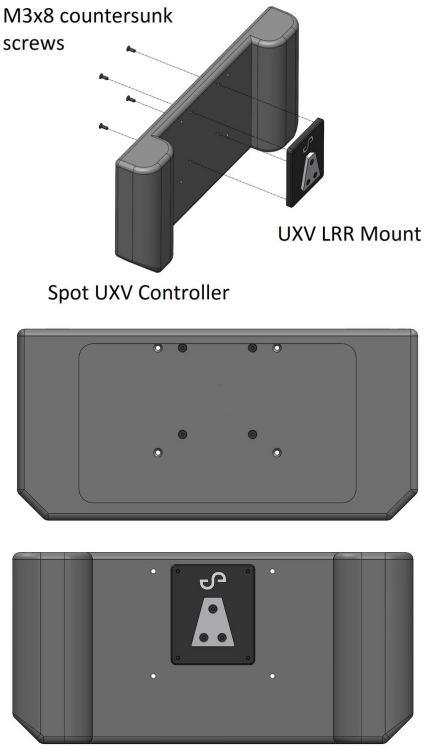
5. Attach the antenna extension lead to the LRR by tightening the SMA connector using the thumbscrew until finger tight.



6. Repeat the above steps to install the right-hand side antenna extension.

## 10.2 Mounting the Groundside LRR

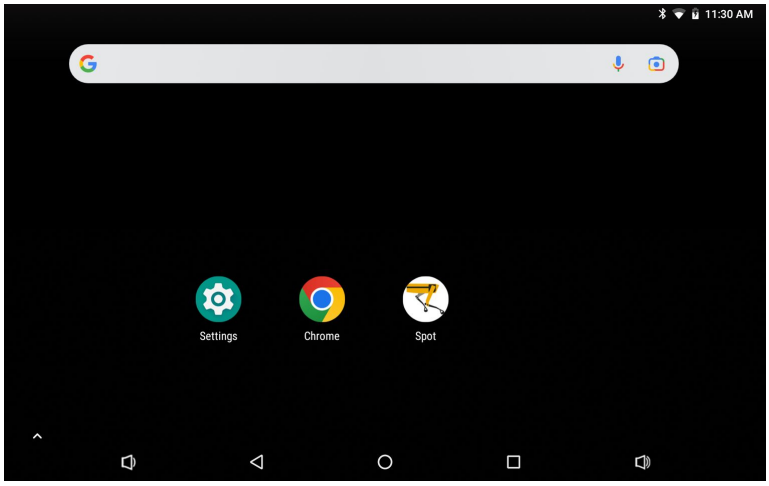
1. Remove the display tablet from the UXV Tab 3 case.
2. Line up the UXV LRR Mount to the inner UXV Tab 3 case mount holes, ensuring the Emesent logo is oriented towards the top.
3. Attach the UXV LRR Mount to the UXV Tab 3 case using the provided four (4) M3x10 countersunk screws. Use Loctite 222 and hand tighten.



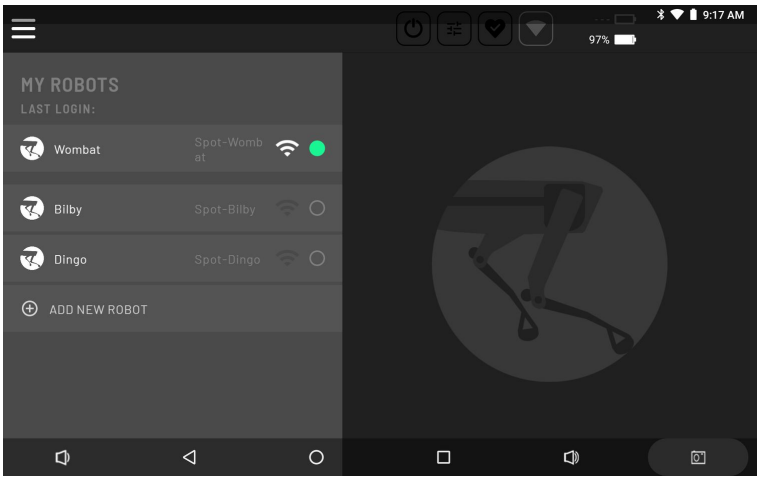
# 11. Setting up the Spot Payload

Before proceeding with the following instructions, it is important that you are already familiar with operating the Spot robot.

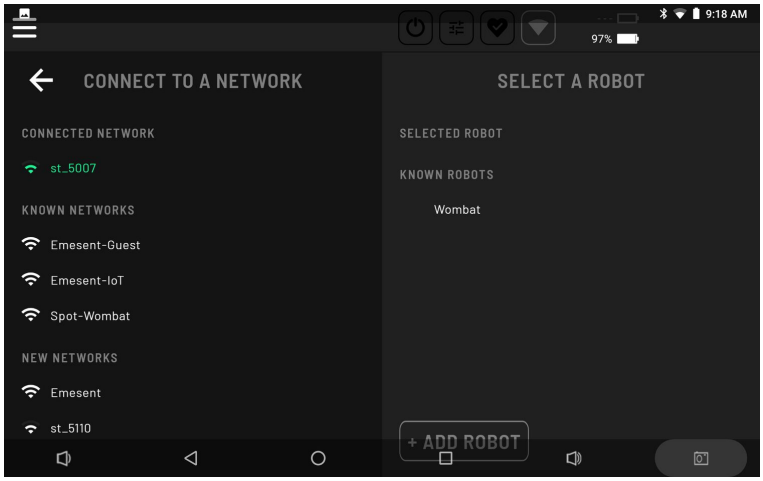
1. Ensure that the cables are all connected securely.
2. Power on the Spot robot and the Hovermap if it doesn't automatically turn on.
3. Launch the **Spot** application from the controller.



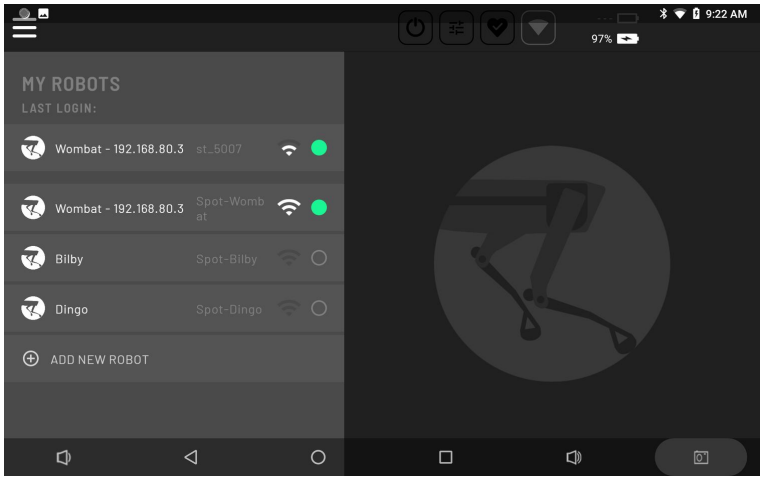

4. Go to the **My Robots** page, where you can find a list of all robots. Beside each robot name, is the corresponding network.



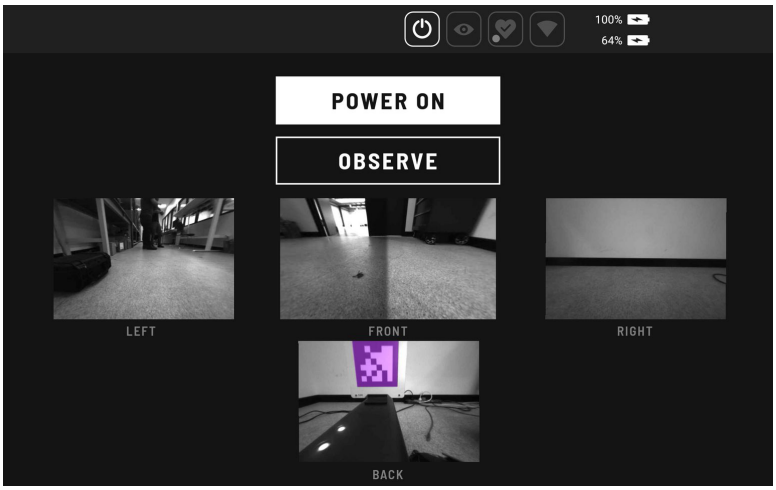
5. Tap **Add New Robot** at the bottom of the list.
6. Select a Hovermap network to connect to on the left, then view the list of detected robots on the right side.



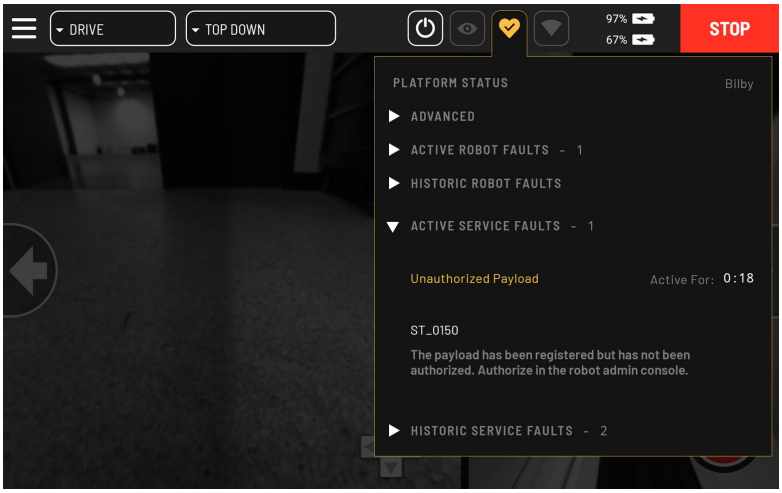

7. Choose a robot from that list then tap **Add Robot**.
8. In the **My Robots** page, tap on the newly added robot to log in.



9. Select **Power On**.

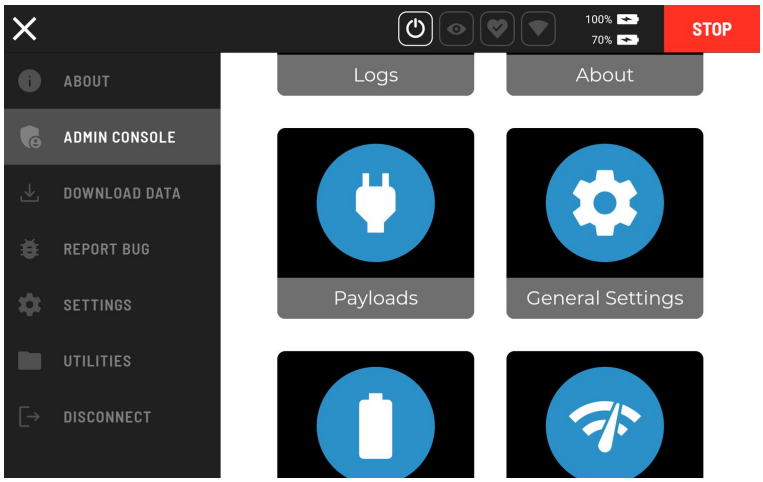



10. Once the Hovermap and Spot are powered on, there will be a flashing amber alert for Platform Status on the Status Bar that will be reporting an “Active Service Fault - Unauthorized Payload” fault. This indicates that the Hovermap has been successfully detected and requires authorization.

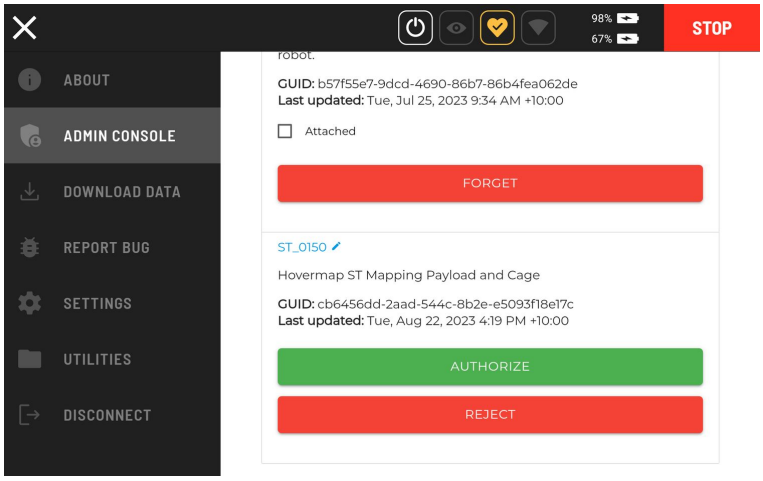



11. Tap the **Settings Menu** on the top left, and navigate to the **Admin Console**.
12. Enter your credentials when prompted.

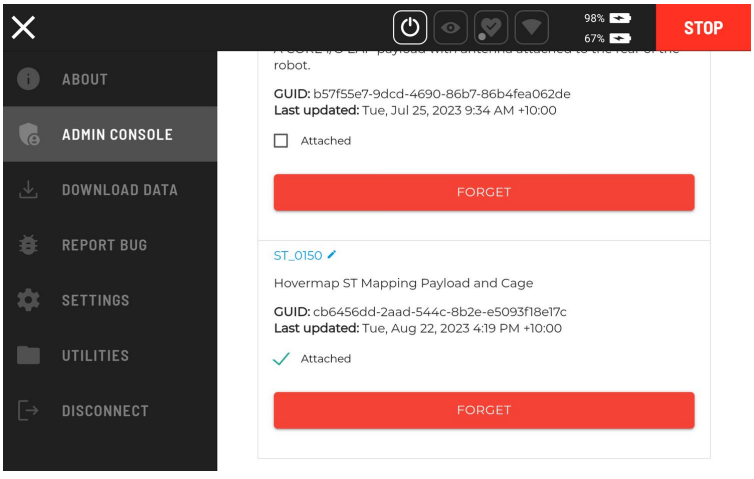
13. Select the **Payloads** icon.



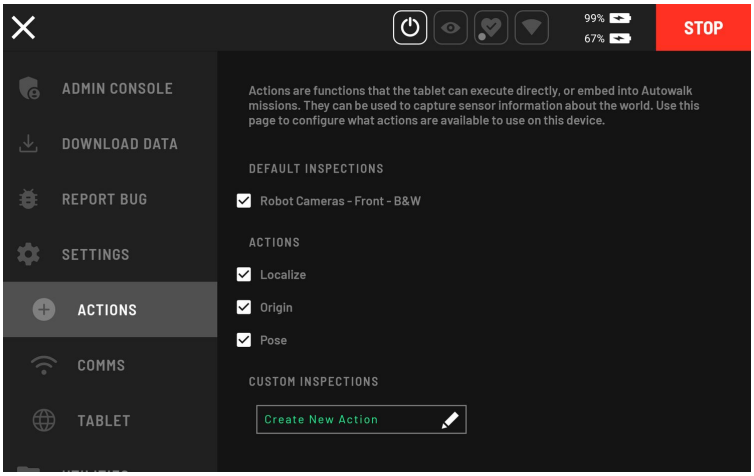

14. Scroll down until the Hovermap payload is shown and tap **Authorize**.



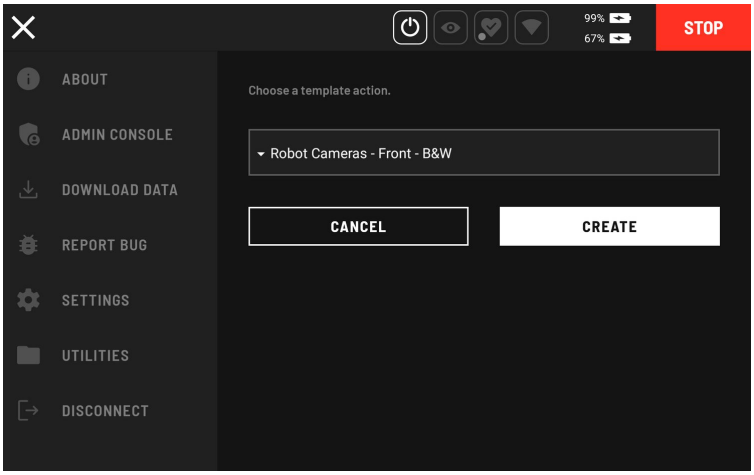

The button then changes to indicate that the authorization is successful.



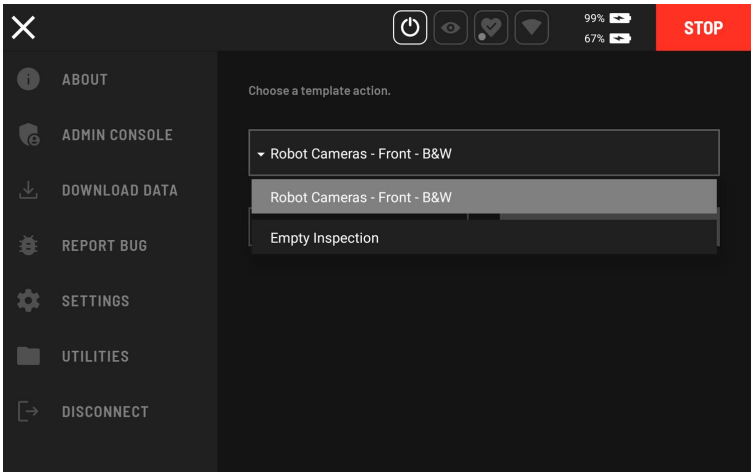
15. In the **Settings Menu**, navigate to **Settings** > **Actions** to configure the start and stop scan actions.



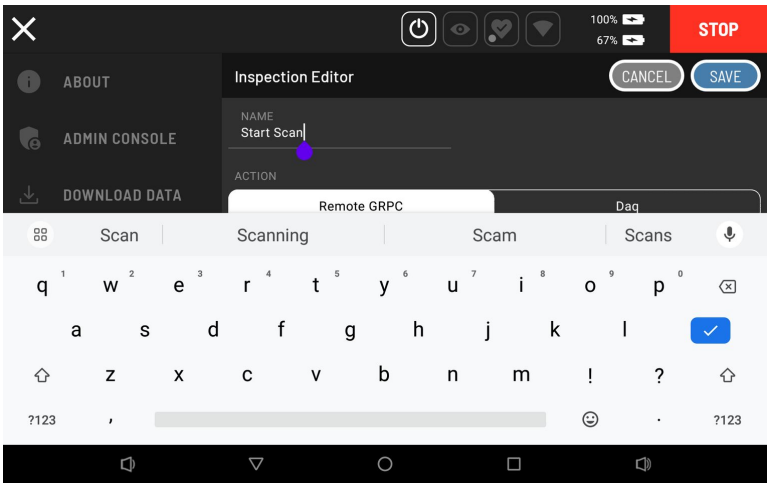

16. Under **Custom Inspections**, tap **Create New Action**.



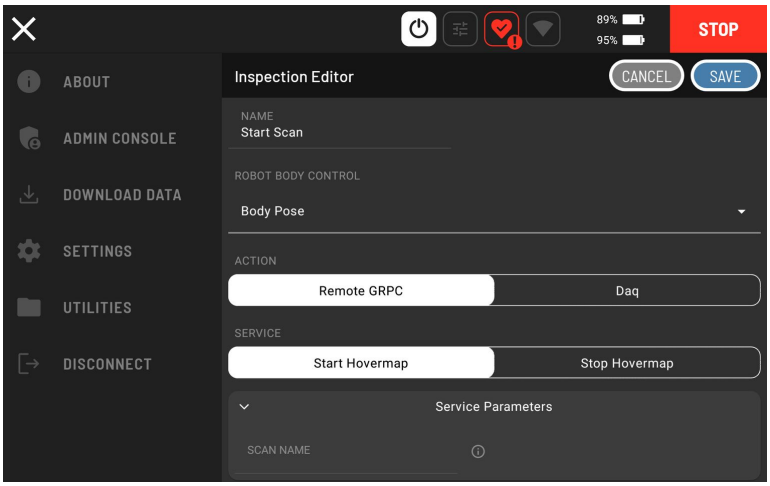

17. Select **Empty Inspection** as the template action from the dropdown.



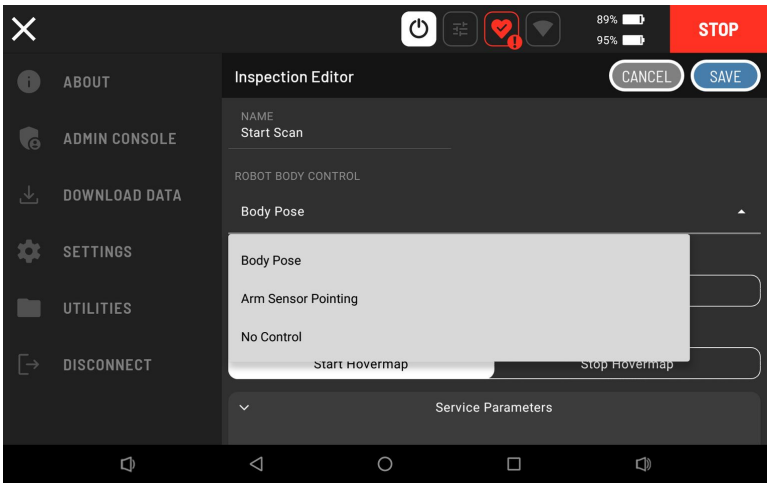
18. Enter a name in the **Inspection Editor** (e.g., “Start Scan”).

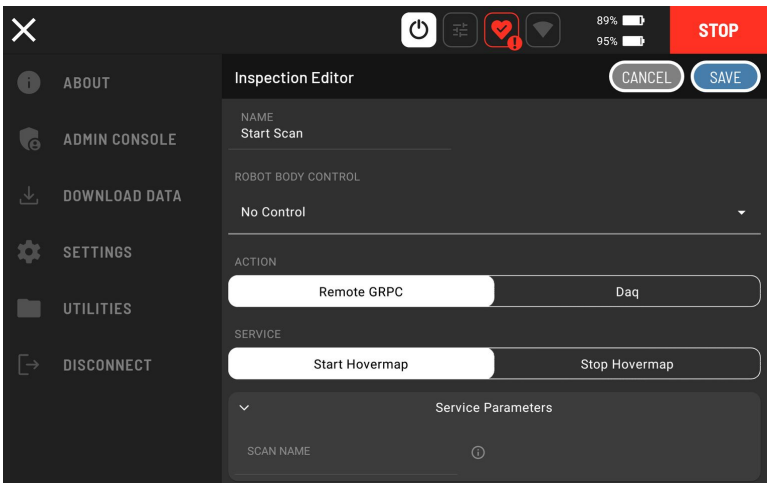



19. Select **Remote GRPC** and **Start Hovermap**.



20. Change the **Robot Body Control** parameter from the default **Body Pose** setting to **No Control**.

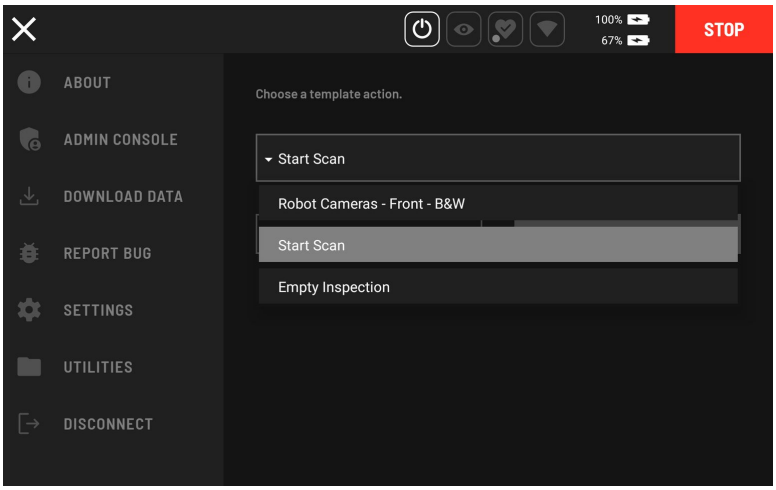


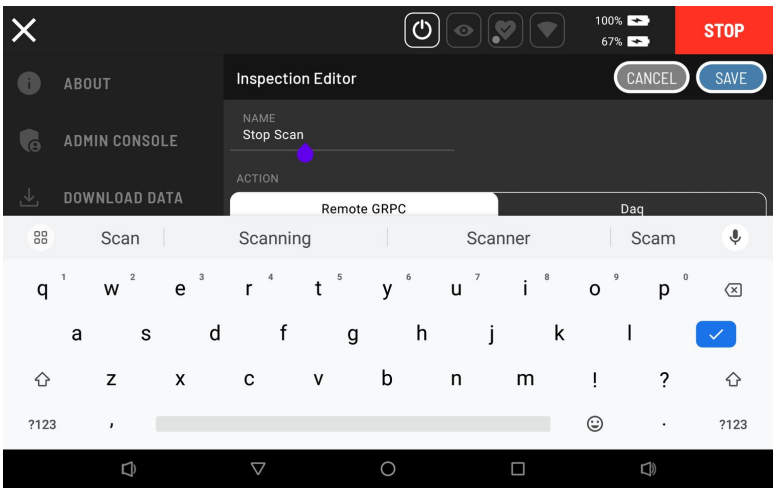

21. Tap **Save** on the top right of the **Inspection Editor** window.

22. In the **Settings Menu**, navigate to **Settings** > **Actions** then select **Create New Action**.

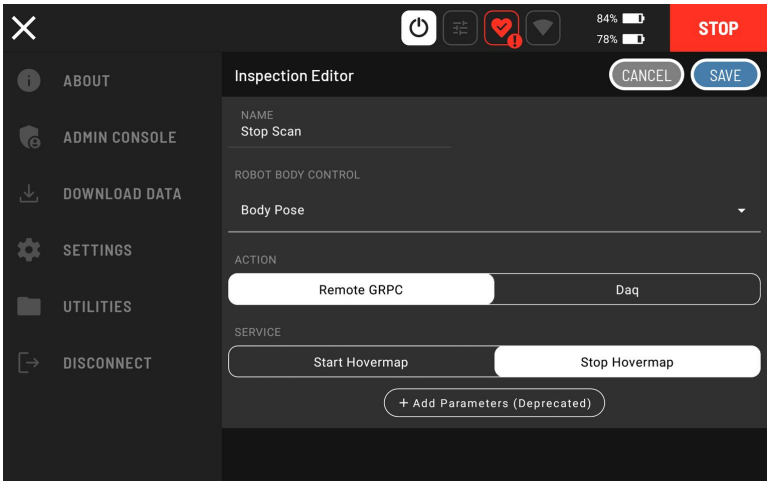
23. For the stop scan action, use **Start Scan** as the template.



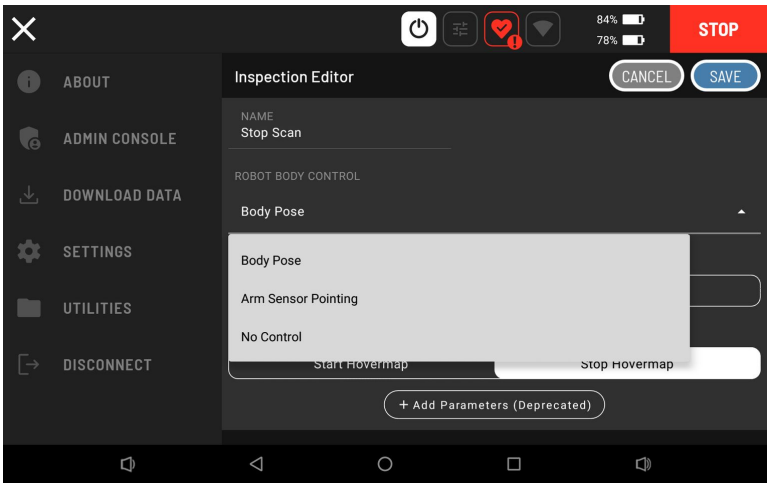

24. Enter a name in the Inspection Editor (e.g., “Stop Scan”).

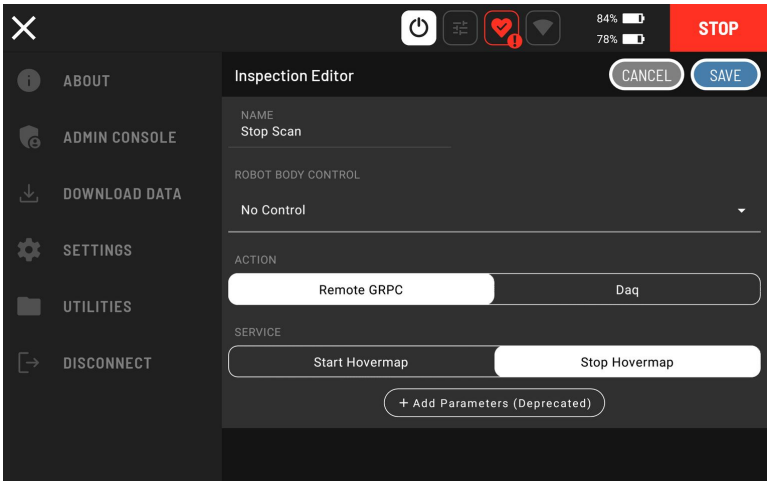



25. Select **Remote GRPC** and **Stop Hovermap**.



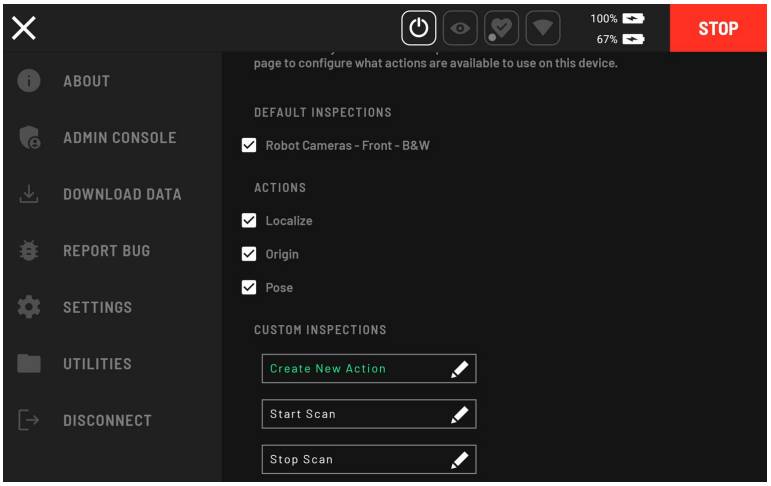
26. Change the **Robot Body Control** parameter from the default **Body Pose** setting to **No Control**.



27. Tap **Save** on the top right of the **Inspection Editor** window.

28. Navigate to **Settings** > **Actions**. Confirm that two extra inspection actions have been added, one to start and another to stop a scan.




29. This completes the Spot payload setup and you can now conduct a mapping mission.

# 12. Connecting to the Long Range Radio (LRR) Network

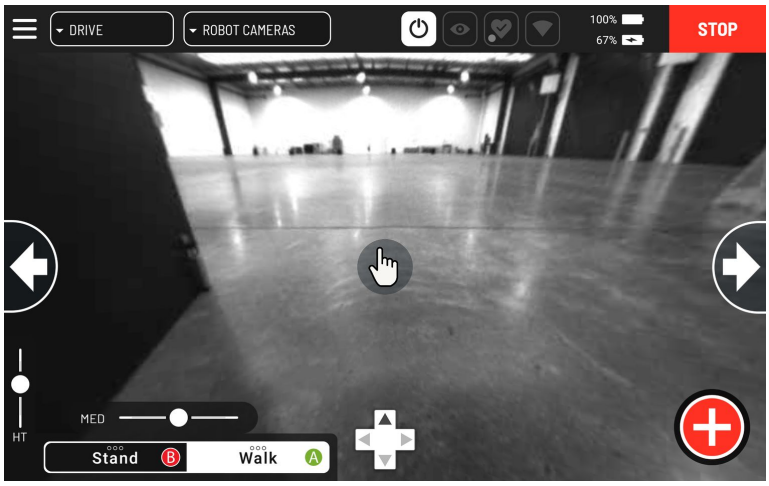
LRR is an auxiliary radio system that extends the data connection to the Hovermap over a longer range than conventional Wi-Fi. This results in operational and safety improvements by allowing access to the streaming point cloud and critical safety telemetry over longer distances.

1. Connect the tablet to the LRR Wi-Fi.
2. Open the Spot app.
3. If the LRR device has already been added, select it from the list of networks. Otherwise, tap **Add New Robot**.
4. Enter the Hovermap's IP address on the LRR network (10.233.0.1). Once connected, it is recommended to keep 5m away from the Spot robot to ensure a solid LRR connection.

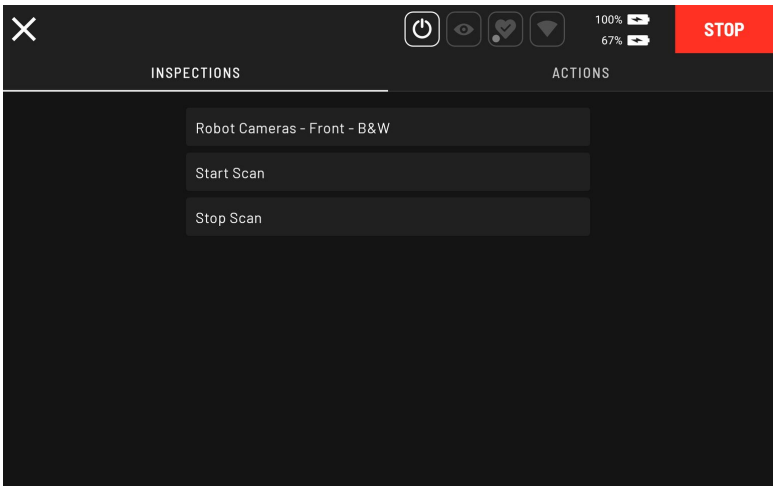
# 13. Conducting a scanning mission

## 13.1 Scanning in Drive Mode

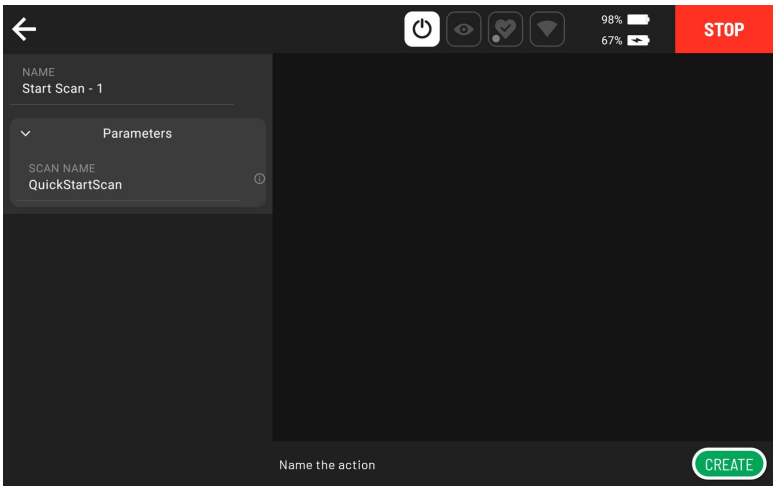
1. To start a scan, tap the red plus icon at the bottom right of the Spot controller.



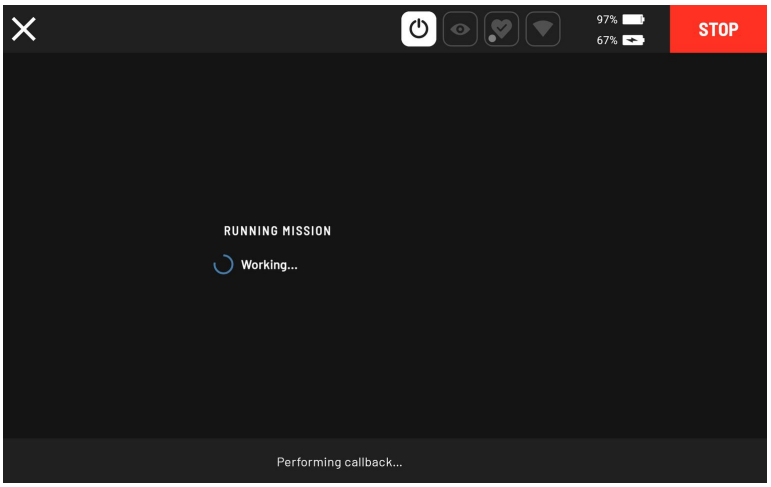

2. Select the **Start Scan** option.



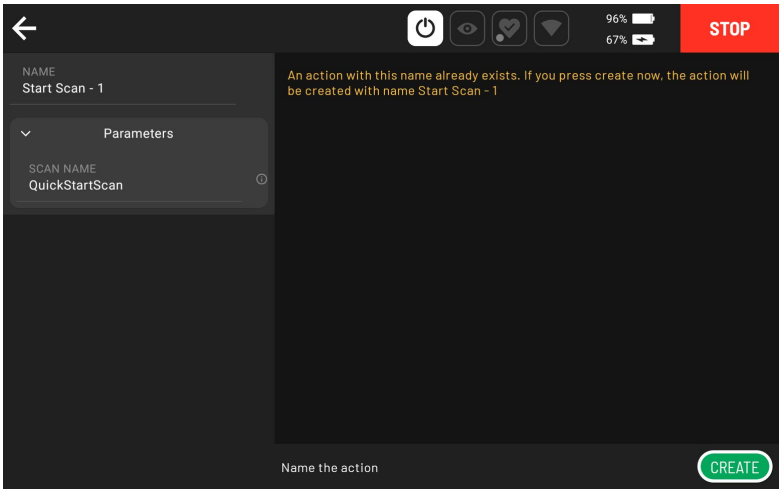
3. Name the scan.



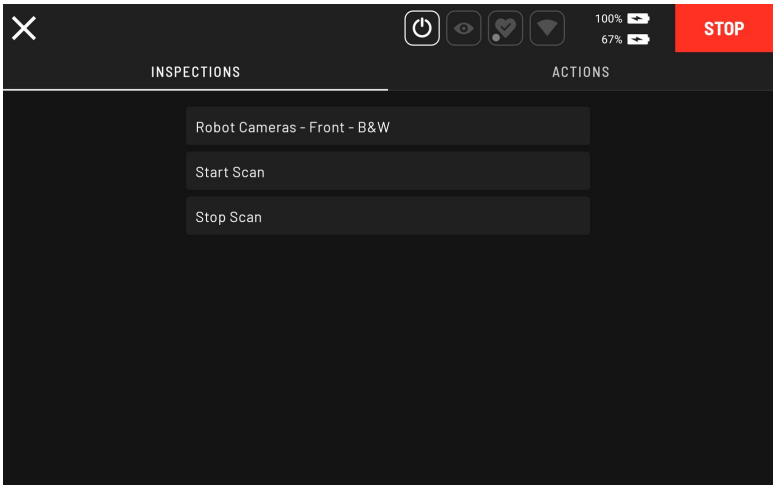

4. Tap **Create** on the bottom right of the controller screen to start the scan. It will take around 30 seconds for the scan to initiate fully. The Hovermap then starts flashing green and the LiDAR starts to rotate.



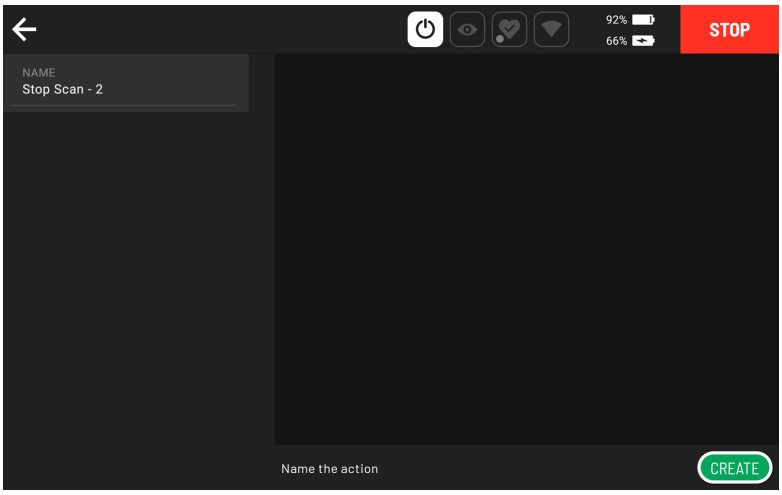
5. The controller display will return to the previous screen, tap the back button on the top left. This will take you back to the main screen where you can operate the Spot robot.




6. Proceed with your scanning mission.
7. To stop the scan, press the red plus icon on the bottom right of the controller.
8. Select the **Stop Scan** option.



9. Tap **Create** to stop the scan.



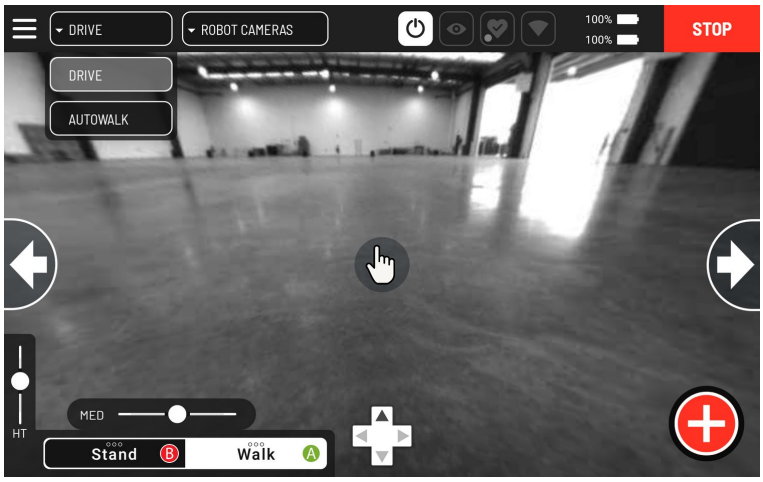

10. Press the back button on the top left to go back to the main Spot screen.

## 13.2 Scanning in Autowalk Mode

Before proceeding with the following instructions, it is important that you are already familiar with Spot's **Autowalk mode** and that the environment is properly configured to ensure successful navigation. For more information on the **Autowalk mode** feature, please refer to the relevant documentation provided by Boston Dynamics (https://support.bostondynamics.com/s/spot/autowalk).

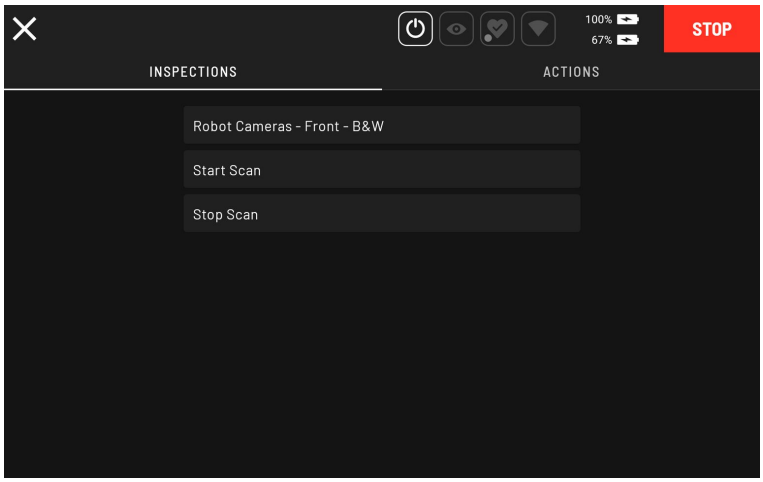
### 13.2.1 Recording an Autowalk with a Mapping Mission

1. Select **Autowalk** from the main screen.

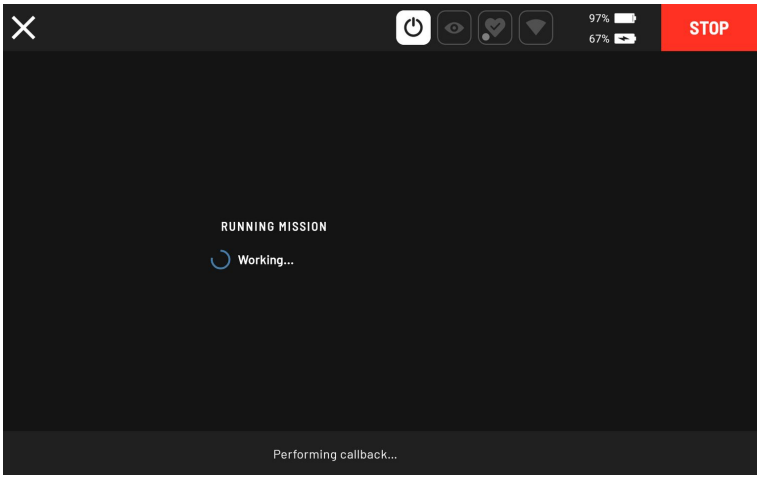



2. From the **Autowalk Options** menu, select **Record**.
3. Name the scan (it is recommended to include a reference to a Hovermap scan). Ensure that **Execute Actions** is toggled **On**.
4. Begin recording the Autowalk mission. Refer to relevant documentation (https://support.bostondynamics.com/s/spot/autowalk) for instructions on conducting an Autowalk mission. At any point, tap the red plus icon at the bottom right of the controller to start a Hovermap scan.

5. Select the **Start Scan** option.

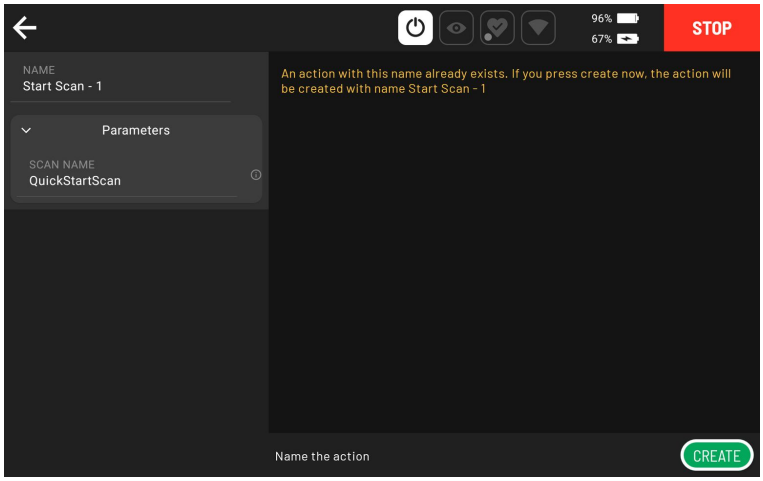



6. Name the scan.
7. Tap **Create** on the bottom right of the controller screen.

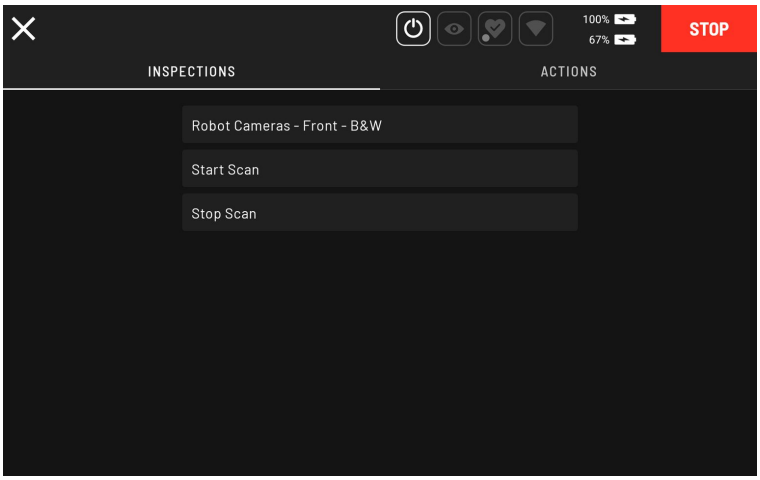



> **Note**
> The scan will not commence while Autowalk is being recorded but will start once the recording is played back. It will take around 30 seconds for a scan to fully initiate, then the Hovermap will start flashing green and the LiDAR will start to rotate.

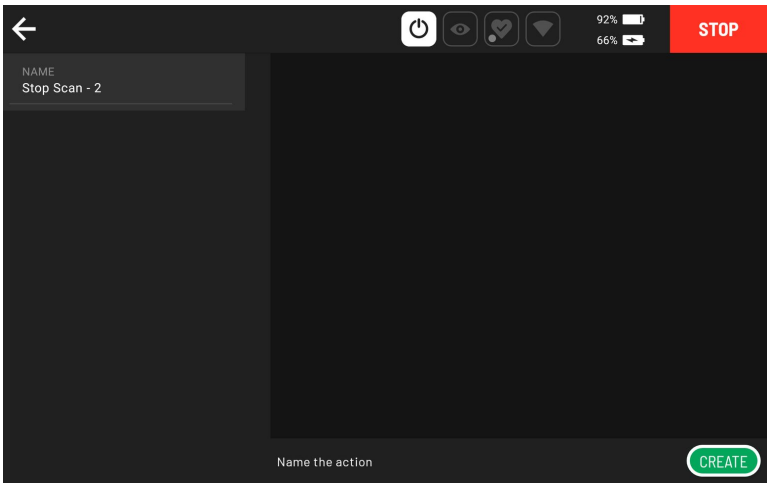
8. The controller display will return to the previous screen. Tap the back button on the top left. This will take you back to the main screen where you can continue with the Autowalk mission while performing the Hovermap scan.




9. To stop the scan, press the red plus icon on the bottom right of the controller.
10. Select the **Stop Scan** option.



11. Tap **Create** to stop the scan.




12. Tap the back button on the top left to go back to recording the Autowalk mission on the main screen.
13. Tap **Finish Recording** to stop the Autowalk mission recording. Configure the remaining options as needed. Refer to the relevant documentation provided by Boston Dynamics for more information.

# 14. Environmental Limitations

Avoid using Spot in the following environments:

- grass
- water
- glass
- lifts/elevators
- hot environments above 35°C

> **Warning**
> It is the operator's responsibility to only use Spot in a safe environment. These guidelines are for reference only. They do not describe every unsafe condition. If an environment or robot behaviour seems unsafe: **STOP**.

## 14.1 Spot Operating Environment

**Source**: https://support.bostondynamics.com/s/spot/autowalk

| Environment | Yes | No |
|---|---|---|
| Surface type | • Low carpet (recommended)<br>• Clean dry pavement<br>• Unwaxed clean indoor floors<br>• Ram board-covered flooring<br>• Grass<br>• Packed dirt and sand<br>• Gravel | • Slippery surfaces<br>  ◦ Wet grass<br>  ◦ Ice<br>• Entrapment hazards<br>  ◦ Rebar mesh<br>  ◦ Sideways ladders<br>  ◦ Netting<br>• Elevated platforms without proper safety barriers<br>• Moving platforms such as vehicles or elevators |

| Environment | Yes | No |
|---|---|---|
| Space | • Clean open space<br>• No objects or people in proximity to Spot<br>• Stay 2m away from Spot when motors are active | • Confined spaces without room for Spot to manoeuvre<br>• Overhanging obstacles<br>• Objects < 30 cm high that should not be stepped on<br>• Thin objects < 3 cm<br>• Glass or clear objects |
| Slopes | +/- 30 degrees | 30 or < - 30 degrees |
| Stairways | Stair dimensions meeting US building code standards, typically 7” (18 cm) rise for 10-11” (25-28 cm) run | • Stairways with open sides<br>• Stairways with people below |
| Climate | • -20C to 45C<br>• Light rain | • Anything outside defined ranges<br>• Do not submerge the robot in water |
| People | All people at least 2m away from Spot | • Untrained personnel onsite<br>• Children onsite<br>• People below the robot operating on elevated ground<br>• People on ladders or scaffolding near robot operating area |
| RF | Limited Wi-Fi and cellular interference | • Conferences, sporting events, and other environments where crowds and devices may interfere with the operator’s ability to control or monitor Spot<br>• Unknown or poor communication performance |

# 15. Other Limitations and Considerations

- Use only cables and hardware provided by Emesent and Boston Dynamics
- Avoid twisting the ribbon cable. This action might compromise its weather resistance.
- Store the port cap in a secure location. The robot will only function when the cap is in place or when a payload is attached to the port.
- When operating Spot with payloads, exercise caution to avoid snag hazards. Secure cables to prevent entanglement and potential damage to components.

# 16. Safety Considerations

- Follow all product safety guidelines as described by Boston Dynamics - https://support.bostondynamics.com/s/spot-product-safety
- Do not attempt to lift the Spot robot using the cables, Spot Cage, or GXP if installed. Only lift at the points as indicated by Boston Dynamics to avoid injury or equipment damage.
- Do not use the Emesent and/or Boston Dynamics provided cables if they appear to be damaged - immediately seek to replace them.
- Do not reach into the payload area of Spot and Cage when Spot is in operation. Only access the area when the robot is powered off or the motors are shut down to avoid injury.
- Be careful of any sharp edges on the Spot Cage and the GXP Riser (if installed). Although Emesent specifies that these edges have a chamfer to minimize the risk, they may become sharp due to impacts from use.

emesent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