HEBI ROBOTICS

Tready Jr / Maggie - Manual

HEBI Robotics

Version 2.1, 12 Jan, 2024

Contents

Revisions

Rev.	Date	Author	Description
0.1	Nov 2022	E Johnson	Initial manual draft.
1.0	Oct 2023	A Willig	Updated with new chassis design, new batteries, new webUI control interface, magnetic attachment details, and additional sensor integration options.
2.0	20 Dec, 2023	A Willig	Updated to be more generic Maggie manual.
2.1	12 Jan, 2024	A Willig	Fixed camera IPs and some other typos.

1. Overview

This manual documents the setup and operation of the HEBI Tready Jr/Maggie Kit.

1.1. Videos

- Inspection Robots Video: https://www.youtube.com/watch?v=tEoKngE73xk

1.2. Technical Specifications

Specifications subject to change without notice.

Power
Tether Max Rating: Power 200W
Nominal Voltage: 48V
Current: 4.1A

Batteries on-board the robot provide an energy buffer for long tether deployments.

2X HEBI Wattman HB36-93 LiGo batteries, 93.6 Watt Hour
Nominal Voltage: 36V
Discharge current: 7.8A continuous, 13A max
Operating Time: 2-3 Hours continuous operation
Dimensions: 220 x 80 x 25 mm
Weight: 650 g (~1.5 lb) per battery

Communications
100 Mbps Ethernet over tether, tested up to 60 m [200 ft] <<<

1.3. Main Components and Features

The Tready Jr/Maggie Mobile Robot Kit comes standard with an IP67 field deployable chassis that includes:

- Sealed bulkheads for all connections required for connecting power and communications
- Front and Rear Facing 1080p 30fps HD Cameras
- Front and Rear High Brightness LED Flood Lights
- Modular interfaces on chassis to mount additional HEBI Components (i.e. arms)
- Universal and configurable T-Slot mounting to the top of the robot using an optical bench style mechanical interface
- "Pull-bar" style attachment for tether protection and safety line attachment
- Two robot-side LiGo batteries that allow for an energy buffer for long tether deployments.

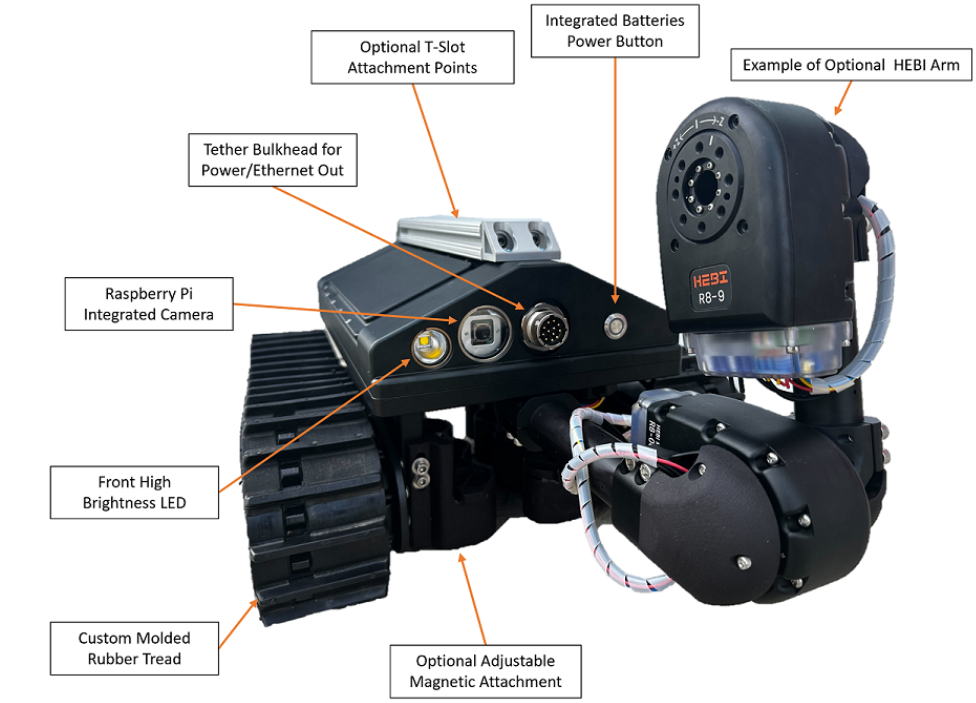
In addition to the standard components above, the kit can be outfitted with:

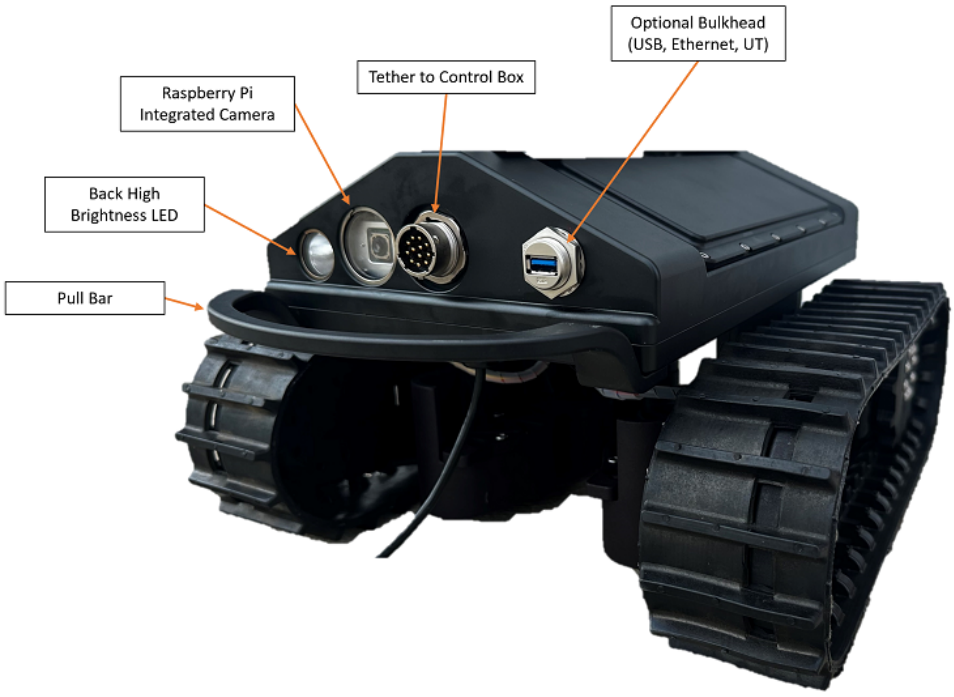
- Magnetic array attachments for crawling on ferrous surfaces
- Additional power and data integration for third-party sensors.

In addition to the field chassis, Tready Jr/Maggie comes with 2 modular track units that includes:

- an R8-16 Actuator to control the driving of the track (swappable to R8-9 for higher speed)
- a custom designed molded track.

a. Tready Jr/Maggie Robot Main Features



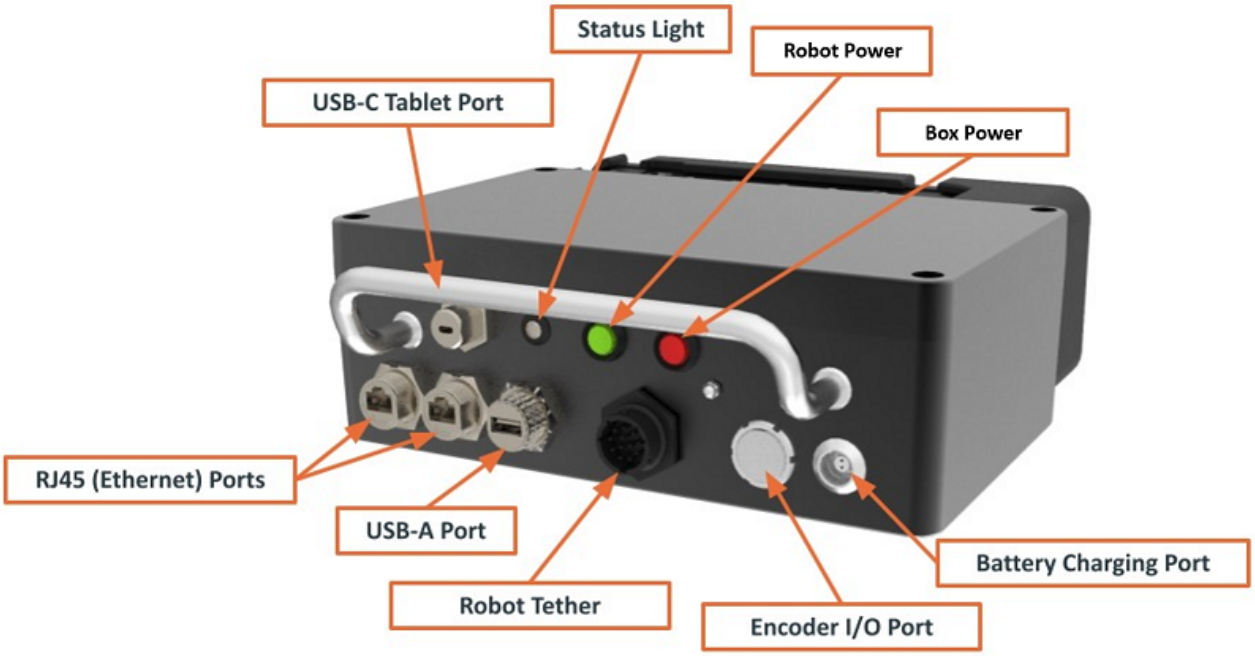


1.4. RBX Control Box

Tready Jr/Maggie is a tethered robot that uses the IP67 HEBI RBX box for communications and power to onboard batteries.

Dimensions: 275 x 260 x 90 mm
Weight: 4.5 kg (10 lb)
Bulkheads:

- Tether Port
- 2x 100 Mbps Ethernet Bulkhead Ports to Internal Switch
- USB-A Bulkhead to Internal Raspberry Pi (Main Control CPU)
- USB-C Tablet Bulkhead for Tablet Charging and Ethernet
- Battery Charger Port
- Encoder I/O Port (Typically not used)



1.5. Accessories

a. Track tensioning tool. This modified clamp is used to retension any tracks that may go slack after extended peroids of use.

b. Each robot kit comes with a set of tools in order to make sure everything is always on hand when working with the robot in the field.

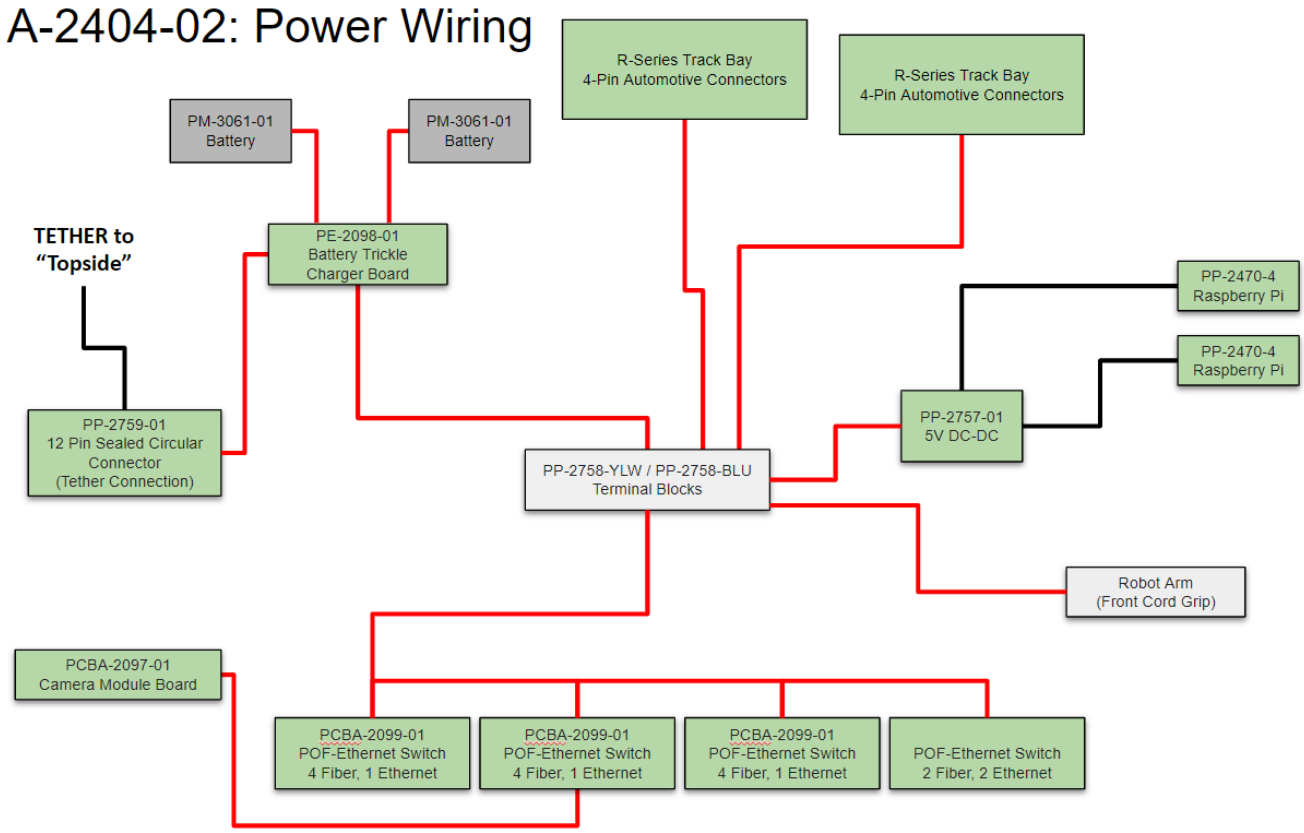
1.6. Datasheets and Drawings

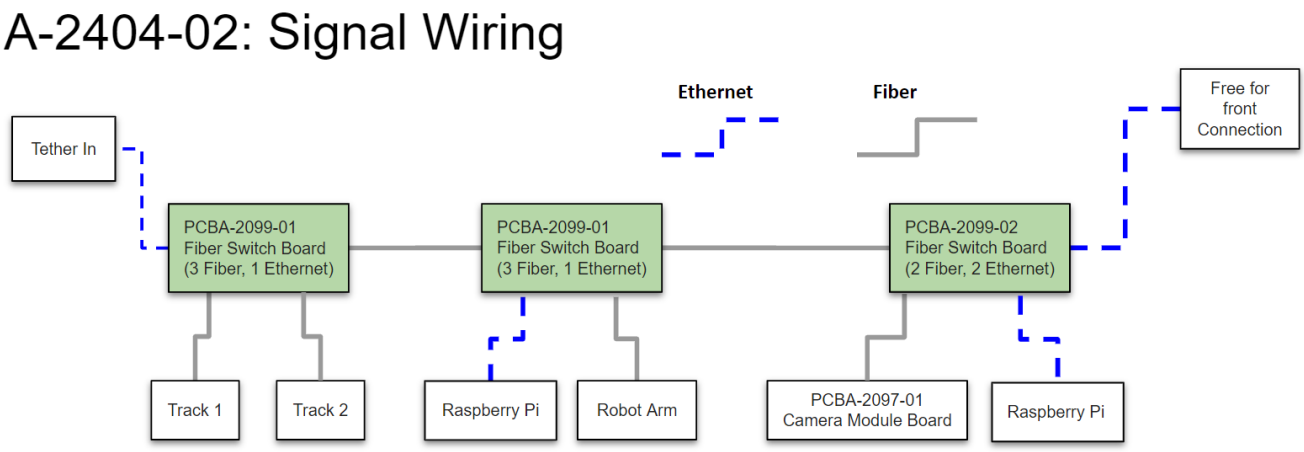
a. R-Series Actuator Datasheet

R-SERIES ACTUATOR — TECHNICAL SPECIFICATIONS

CONFIGURATION	R8-3	R8-9	R8-16
Peak Torque **Cont. Torque** **Max Speed**	7 N-m 3 N-m 84 RPM	20 N-m 8 N-m 30 RPM	38 N-m 16 N-m 15 RPM
Mass	670g	685 g	715 g
Dimensions	156mm x 78mm x 51mm 15mm hollow bore		
Power	24-48V DC Cont. Current: 1.3 A @ 36V Peak Current: 3.0 A @ 36V		
Environment	-10°C to 50°C Ambient / IP67		
Communication	2X 100 Mbps Plastic Optical Fiber (OptoLock®)		
Angular Resolution	0.005°		
Torque Resolution	0.01 Nm		
Backlash	+/- 0.25°		
Sensing	Angular Position (multi-turn absolute, +/- 4 turns) Angular Velocity Output Torque 3-axis Accelerometer / Gyro Temperature Voltage Current Internal Pressure		
API Support	MATLAB (Windows / Linux / OS X) ROS (Linux) Python (Windows / Linux / OS X) C/C++ (Windows / Linux / OS X) C# (Windows)		
Each order of R-Series Actuator includes a standard connection kit. Additional technical documentation at docs.hebi.us Updated on October 1, 2021. Specifications subject to change without notice.			

1.7. Wiring Diagrams





1.8. For More Information

HEBI Documentation (docs.hebi.us)

- Quick-start guides
- Core concepts background information
- Mechanical documentation
- Software walkthroughs
- Downloads

HEBI Community Forum (forums.hebi.us)

- Regularly monitored by HEBI Engineers
- Collaborate with fellow HEBI users
- A platform to share your successes

HEBI CAD Repository (cad.hebi.us)

- CAD files and drawings

Contact Us

HEBI Robotics
3577 Bigelow Blvd, Floor 3
Pittsburgh, PA 15213
info@hebirobotics.com

2. Robot Startup

2.1. Power On

1. Press the red button on the RBX Control Box to power on the box.
2. Wait for the single, then double beep from the box to know that the router in the box is fully started.
3. Power on the robot by pressing the button on the chassis on the robot.
4. Press the green button on the RBX Control Box to connect the box to the robot.
5. When the status light is slowly blinking green that indicates that the box has found an IP from the internal router. When the actuators on the robot are slowly blinking green that indicates that the robot has connected to the box successfully.

2.2. Connections

The following connections should be made for controlling the robot system:

- The **iPad** should be connected to the USB-C port on the RBX Control Box. This will charge the iPad as well as connect it to the network in the box.
- **An external laptop** can be connected to either of the other LAN ports using the laptop's ethernet port or an ethernet-to-USB adapter. This will put the laptop on the robot's network. This is how you will start/stop the control code and can look at/download sensor data. Additionally, the **HEBI Scope** application can be opened on this device to check connections and feedback to the various components in the robot.

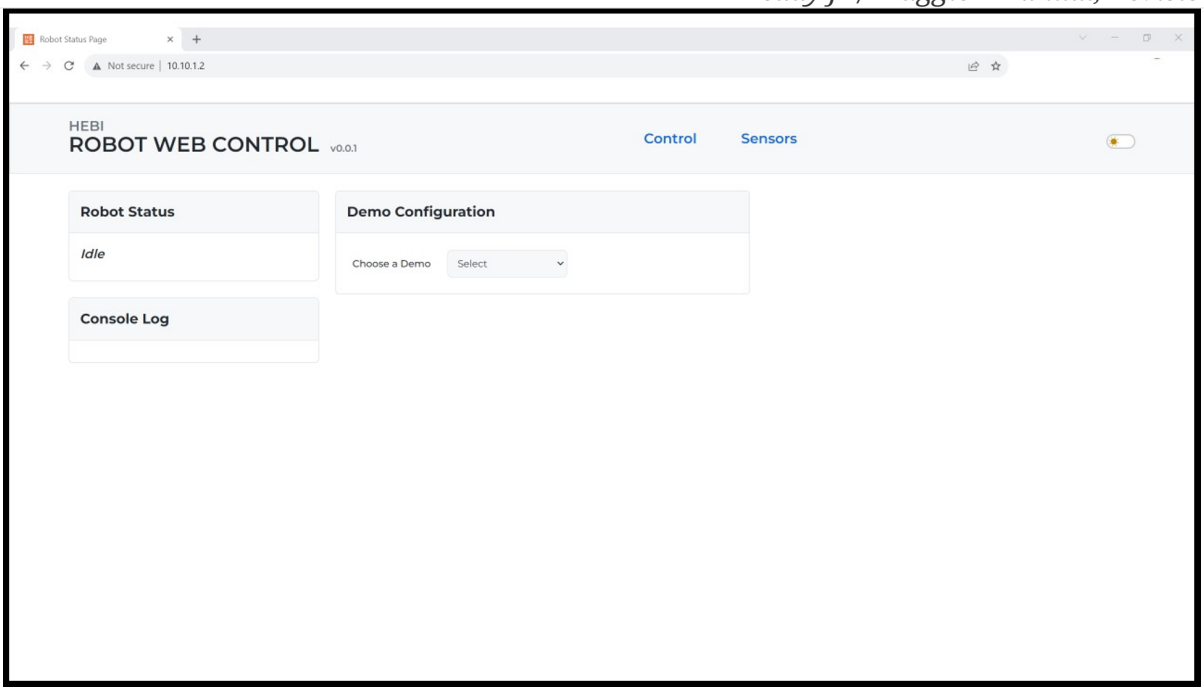
2.3. WebUI Interface

A webpage-based user interface was created for controlling the main code components of the robot system. This UI is an interface between the operator and the control CPU (Raspberry Pi 4) located in the RBX Control Box.

Main Control Webpage IP Address: ***10.10.1.2***

From this webpage you can see and control:

- Robot Status: the current demo running on the robot or *idle*.
- Console Log: a stream of log data/output in case there are any errors or feedback required from the control code.
- Demo Configuration: selectable drop-down menu to choose which demo code to run
- Misc demo start/stop: the example configured webpage below has the ability to start/stop the additional suction anchor demo that is currently under development [Oct 2023].



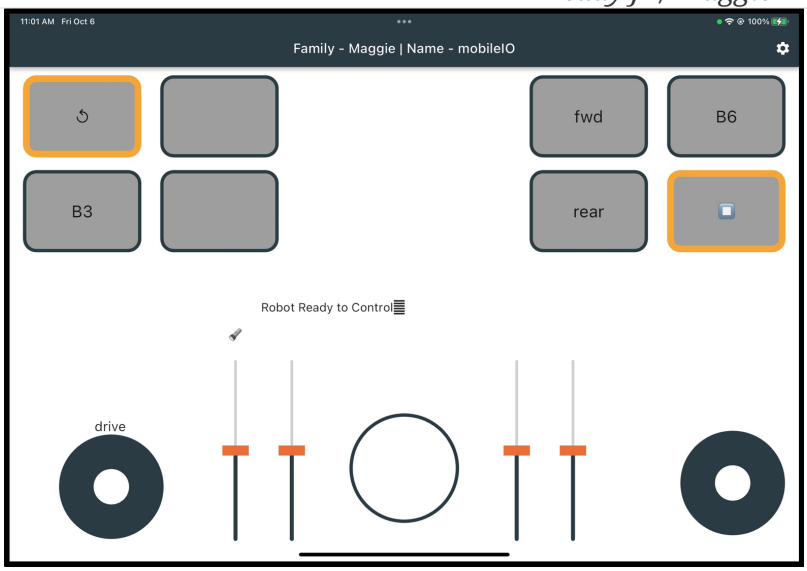
2.4. Control Interface (HEBI Mobile IO App)

The robot is controlled using HEBI Mobile I/O, a free iOS and Android app. Options can be customized based on configuration and need using the HEBI APIs. More information on how to get started and customize the inputs and outputs using the app can be found at https://docs.hebi.us/tools.html#mobile-io

This interface has been specifically configured for the Magnetic Crawler version of the robot with a 2-DoF arm and pXRF sensor. The controls are mapped to the following:

- *reset arrow* : This button will reset the robot to it's initial working state (not recommended).
- *fwd*: Toggle the power to the front flood LED light.
- *rear*: Toggle the power to the rear flood LED light.
- *stop button*: Ends the robot demo in case something needs to be immediately quitted (not recommended).
- *drive joystick*: Use this left joystick to move the robot along the surface using arcade drive. Left and Right turns the robot in place. Up and Down moves the robot forward and back where the arm is the 'front' of the robot.
- *flashlight slider*: This slider sets the brightness of both LED lights. If the LEDs are toggled on, but the slider is too low, the LEDs will be off.

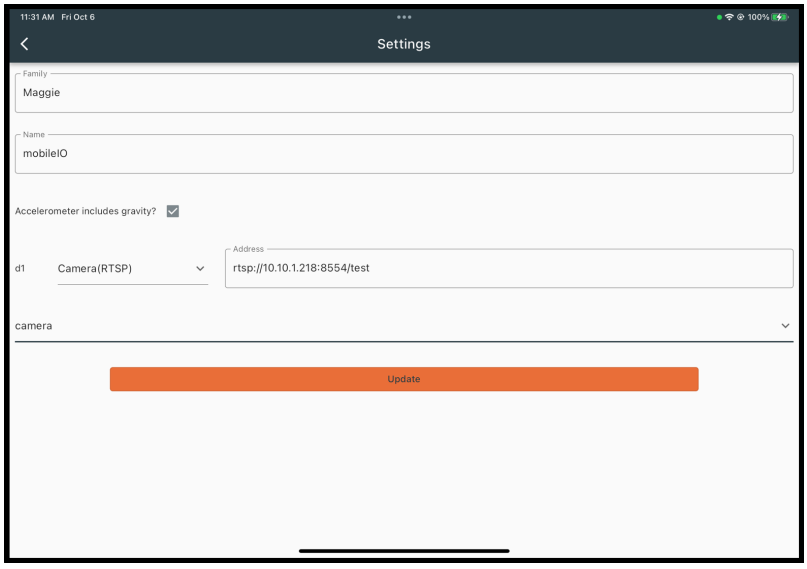
Not every control layout is the same depending on the robot configuration purchased.



Mobile IO Settings

Make sure that the correct Family and Name are set on your mobile device in the "Mobile I/O" Settings.

Family: ***Maggie***
Name: ***mobileIO***



As of Oct 2023 the cameras do not properly work in the Mobile IO App. These streams can, however, be brought up on a laptop connected to the RBX Control Box using the HEBI Scope / Video Tools or a separate Mobile IO App running just the camera display configuration.

The video streams are streamed on the following RTSP stream addresses.

Front facing camera stream IP: ***rtsp://10.10.1.202:8554/test***
Rear facing camera stream IP: ***rtsp://10.10.1.201:8554/test***

If these are not the correct camera IPs, contact HEBI Robotics for debugging and helping to determine what IP the cameras were set to during production.

3. Robot Assembly / Disassembly

3.1. Order of Assembly

1. Take everything out of pelican cases and carefully lay it out.
2. If you traveled by Air, install the **Batteries** into both the Control Box and Chassis as explained further in this section.
3. Connect the tether between the Robot and the Control Box.

3.2. Changing Batteries on the Control Box

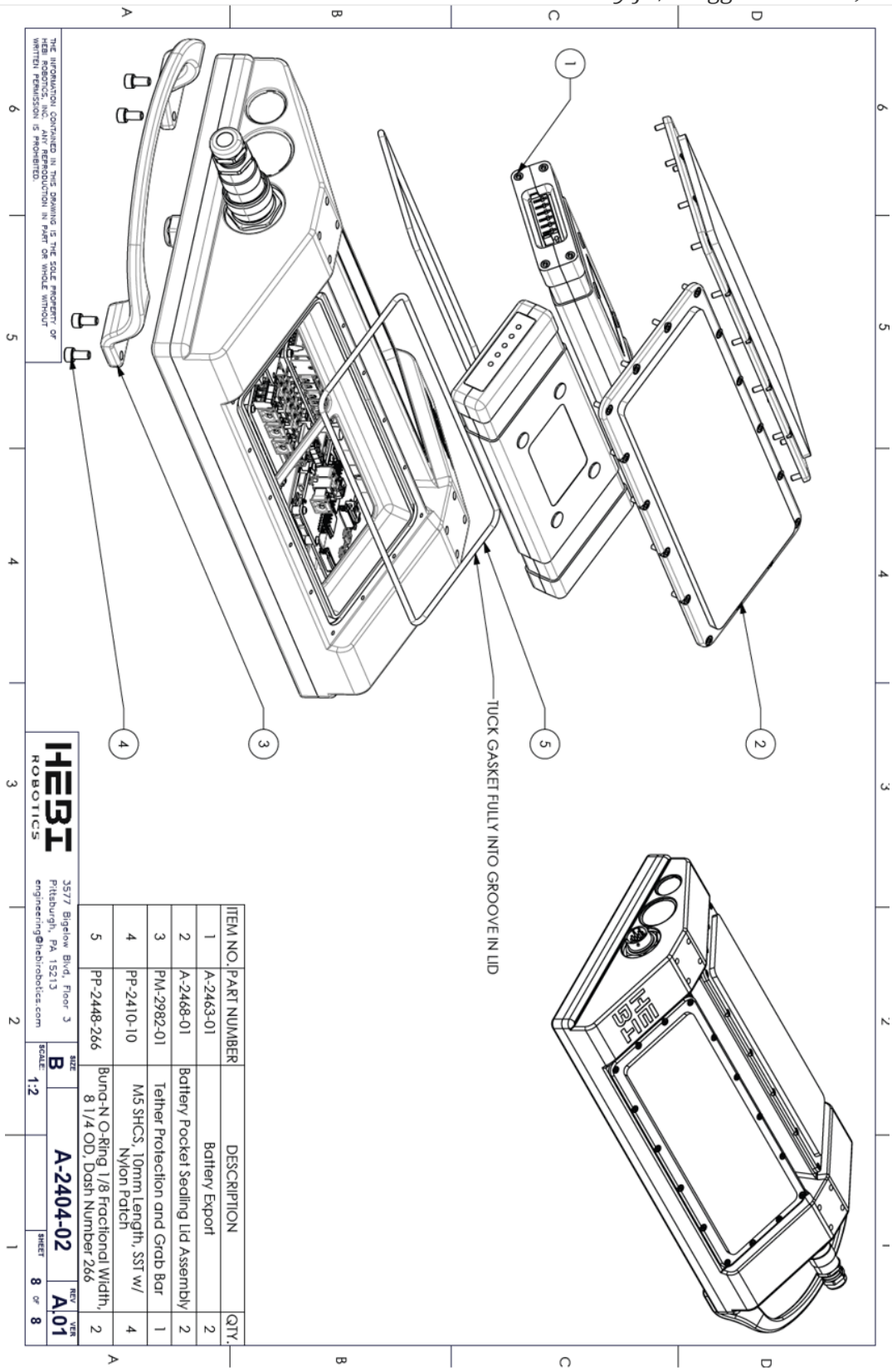
1. The batteries on the control box are located on the back housing. To change out the batteries remove the side cap that does not have any markings (left side when looking at front of box). The batteries can be hot-swapped so you can change them out one at a time while the box is still on. They will slide in and out of the housing in the rear of the box directly into a connector.

When Charging the batteries the batteries need to be ON.

3.3. Changing Batteries on the Robot

1. The batteries on the robot are located inside of the chassis and only need to be removed when traveling on airplanes with the robot. Each battery is located underneath the individual panels on top of robot's chassis. These are held on by M3 screws. Once all screws and the panel is removed the battery must be unscrewed from the connector cap it is plugged into. This connector cap is attached using captive M3 screws.

DO NOT DISCONNECT ANY WIRING, ONLY DISCONNECT THE BATTERY FROM THE CAP.



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	A-2463-01	Battery Export	2
2	A-2468-01	Battery Pocket Sealing Lid Assembly	2
3	PM-2982-01	Tether Protection and Grab Bar	1
4	PP-2410-10	M5 SHCS, 10mm Length, SST w/ Nylon Patch	4
5	PP-2448-266	Bung-N O-Ring, 1/8 Fractional Width, 8 1/4 OD, Dash Number 266	2

3.4. Packing Lists

Box 1 Packing List

Contents:

- Maggie w arm

Weight: 68 lbs

Box 2 Packing List

Contents:

- Maggie tether
- Control box
- Control box charger
- iPad Tablet
- Connection cables (Ethernet and USB-C)
- Toolbox (with extra hardware/screws)
- Track Tensioner

Weight: 60 lbs


NOTE:
This iPad has been set up with a temporary AppleID for initial testing of your HEBI Robotics Kit.
When you have an internet connection, please erase the iPad:
Go to Settings > General > Transfer or Reset iPad.
Then set the iPad up again with an AppleID of your choice.
You can then re-install the HEBI MobileIO App at the link below.

4. Magnetic Attachment Components

4.1. Halbach Magnetic Array

The Maggie configuration of the Tready Jr Robot Kit is equipped with magnetic attachment assemblies that allow the robot to crawl along ferrous surfaces. The magnetic attachments utilize a specialized linear arrangement of nine cubic neodymium magnets, known as a Halbach Array. In this array, each consecutive magnet in the line is rotated 90 degrees. This allows the magnetic field to be concentrated towards the contact surface, creating up to 45% greater field strength when compared to a standard aligned poles arrangement. The array also weakens the magnetic field on the top of the attachments, protecting the robot's internal electronics from magnetic interference.

Figure 1. Illustration of magnets arranged in a Linear Halbach Array.

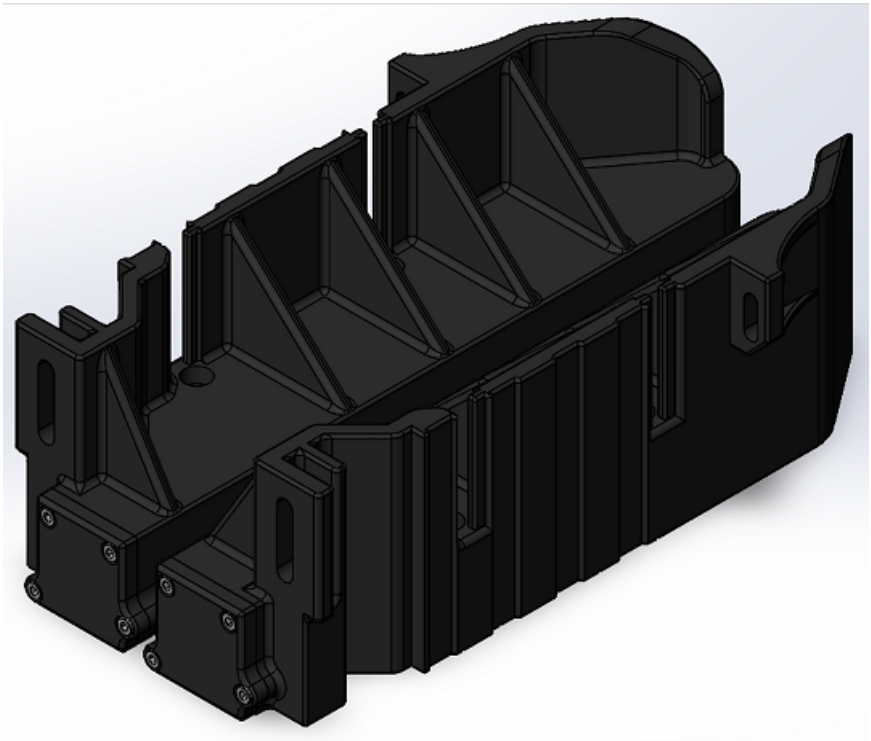


Figure 2. Isometric view of magnetic attachment assemblies in Maggie Robot.

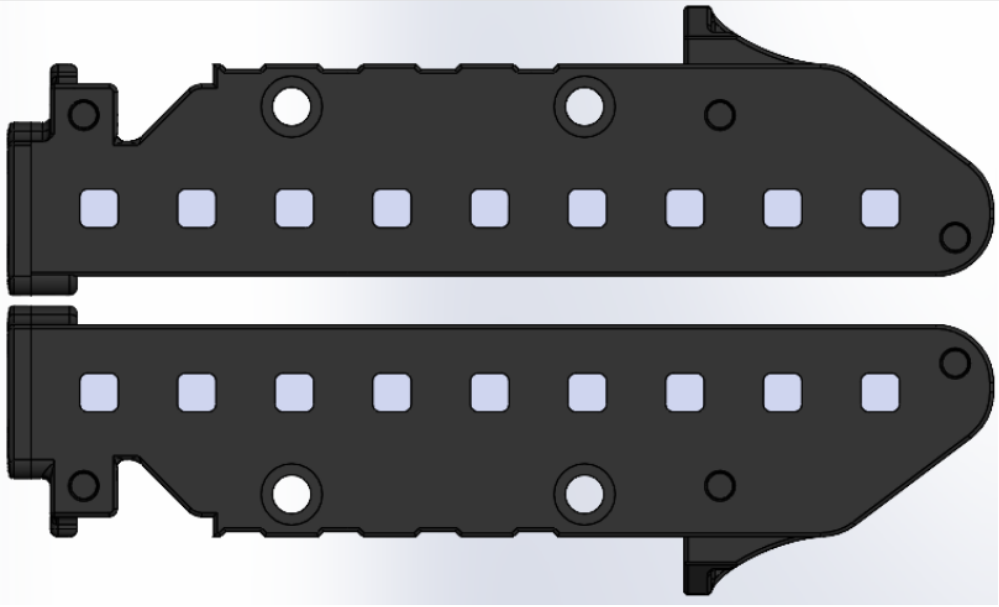


Figure 3. Rendered underside view of magnetic bay assemblies.

4.2. Adjusting Magnet Mounting Height

The height of each of the Magnet Bays can be individually adjusted relative to the base of the robot. This will change the effectiveness/strength of the magnetic field holding the robot up onto the ferrous surface. If mounted too low the bays will rub against the surface, but if mounted too high, there will not be enough magnetic pull force to hold the robot onto the surface.

To adjust the height of the Magnet Bays:

1. Flip the TreadyJr/Maggie so you have access to the underside of the robot.
2. Loosen or remove the M5 locking screws at the front and back depending on the amount of travel needed (Figure 4 and Figure 5).
3. Locate the pair of M8 bolts, found through the bottom face (Figure 6).
4. Turn each an equal amount to maintain level. Each full turn travels the Magnet Bays by 1.25mm.
5. To raise the bays, turn the bolts clockwise. To lower, turn the bolts counter-clockwise and apply downward pressure on the top surface of the bay.
6. Once adjustments are made, re-tighten the front and back M5 screws to lock the height.

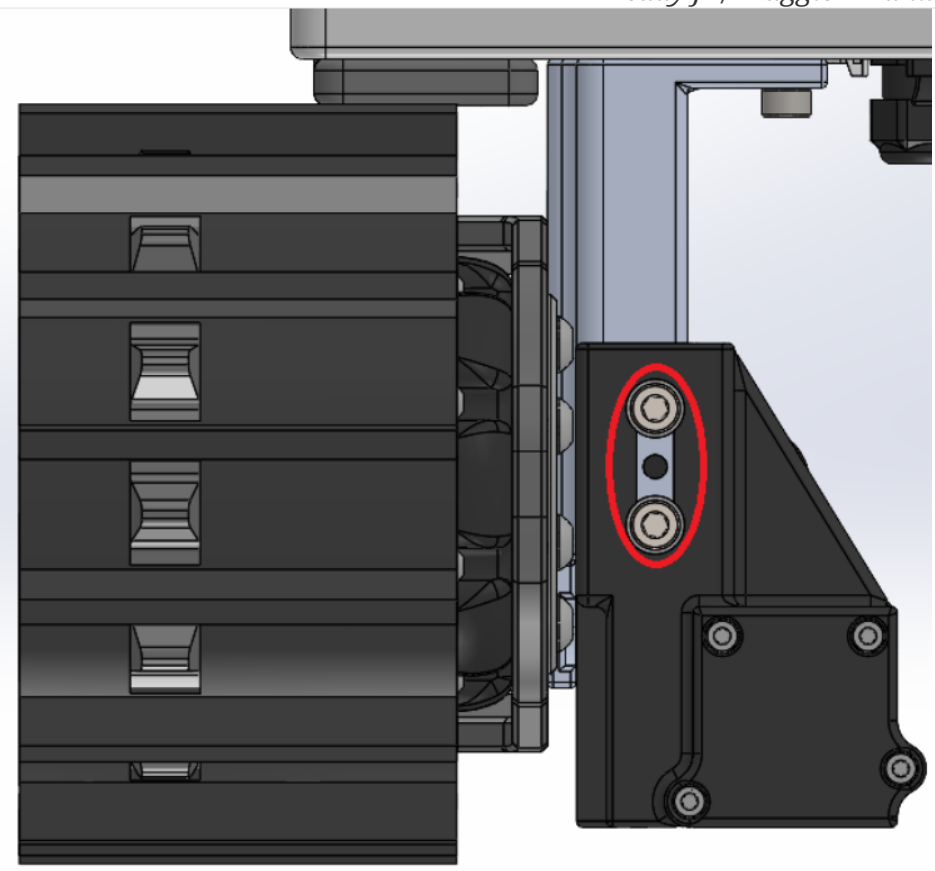


Figure 4. Front location of M5 locking screws for Magnet Bay height adjustment.

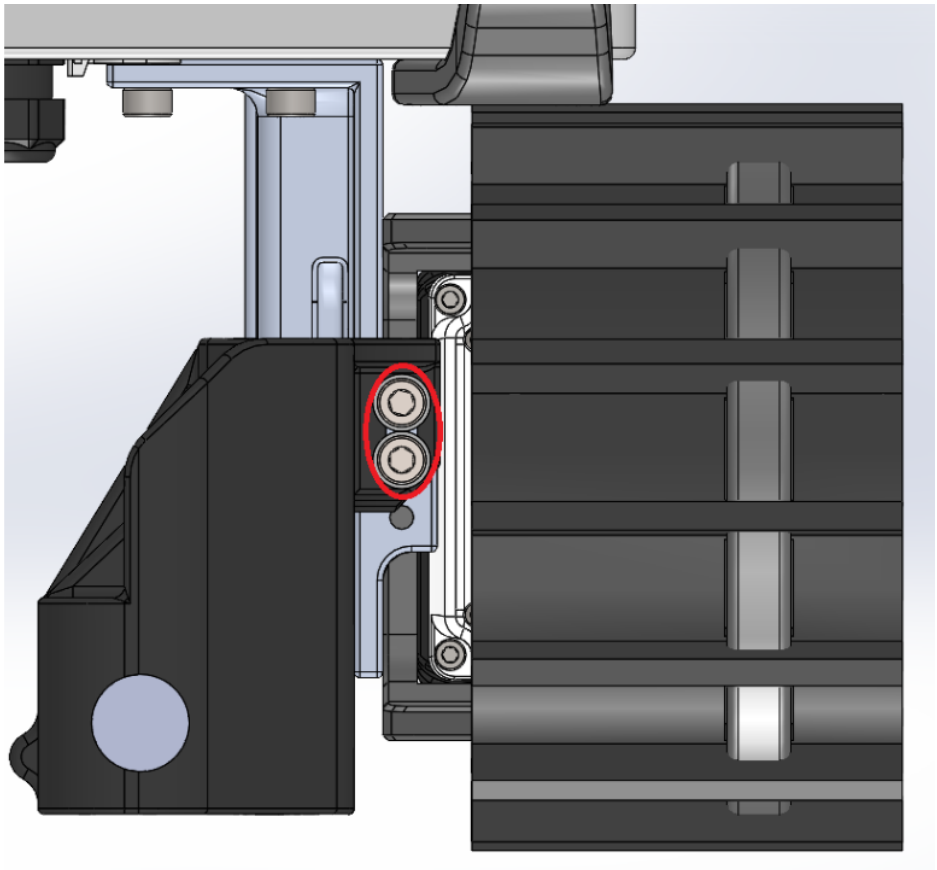


Figure 5. Rear location of M5 locking screws for Magnet Bay height adjustment.

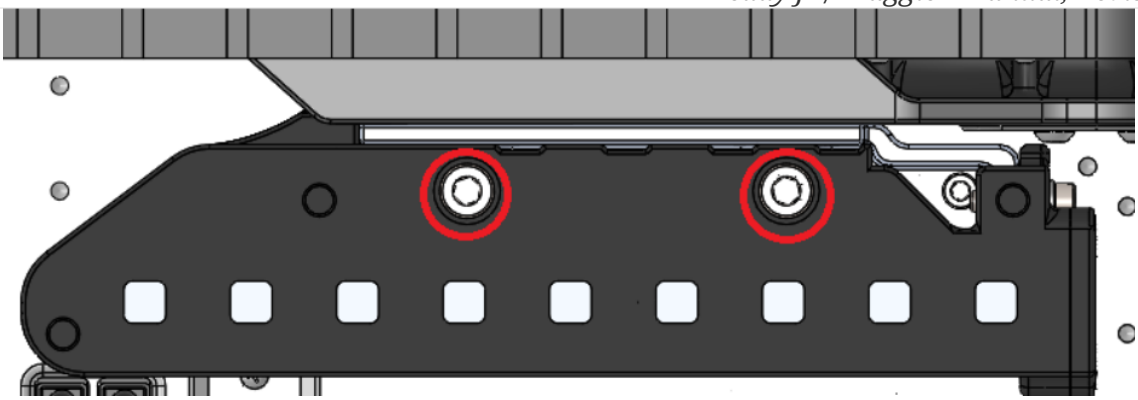


Figure 6. Underside location of M8 screws for Magnet Bay height adjustment.

5. Appendix

This appendix addresses some bugs in the current robot demo and how to resolve them.

5.1. Video does not work on current Mobile IO App

Failure Description: There is a known current bug with the latest release of the HEBI Mobile IO App where the cameras on the robot cannot be streamed through the controller app.

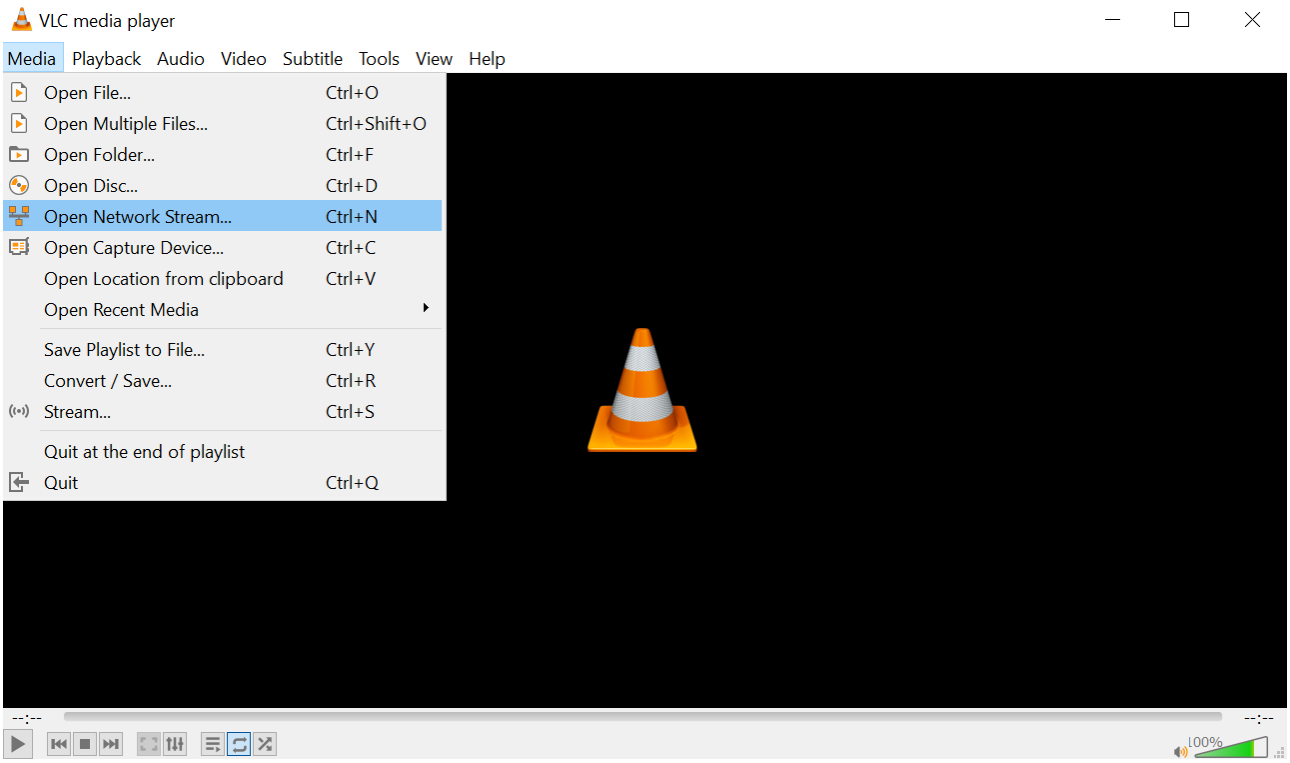
Resolution: In order to demonstrate the cameras from the robot they can be streamed using ***VLC Media Player***.

What is needed:

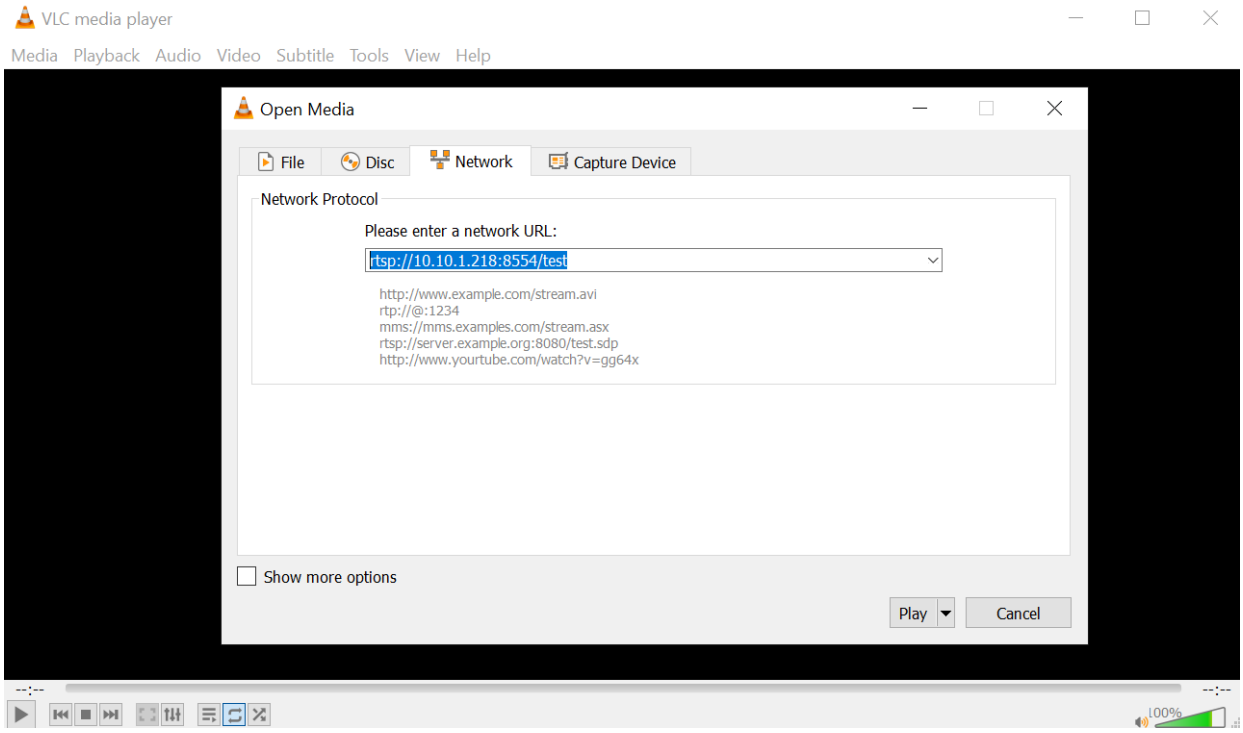
- Laptop w/ VLC Media Player
- Ethernet cable with USB-to-ethernet converter to connect Laptop to Control Box

Steps:

1. Wire and connect the Laptop to one of the **LAN** ports on the Control Box. You can make sure the Laptop is properly connected by opening up a web browser and going to ***10.10.1.222:8081*** (Main Control Webpage) and checking that it properly shows up.
2. On the Laptop, open up ***VLC Media Player*** and go to ***Media*** > ***Open Network Stream***



3. Under 'Please enter a network URL' you can enter the following to view the different cameras:
    - Front facing camera stream URL: ***rtsp://10.10.1.219:8554/test***
    - Rear facing camera stream URL: ***rtsp://10.10.1.218:8554/test***


VLC media player
Media Playback Audio Video Subtitle Tools View Help
Open Media
File Disc Network Capture Device
Network Protocol
Please enter a network URL:
rtsp://10.10.1.218:8554/test
http://www.example.com/stream.avi
rtp://@:1234
mms://mms.examples.com/stream.asx
rtsp://server.example.org:8080/test.sdp
http://www.yourtube.com/watch?v=gg64x
Show more options
Play
Cancel
--:--
--:--
100%