

Autonomous Delivery Robot

Operating manual

v2021_02_17

www.marvelmind.com

Table of contents

1. Executive summary	4
1.1 Legend	7
2. Robot's functionality	8
2.1 Obstacle avoidance and detection	8
3. Robot's optional features	9
3.1 QR-scanner	9
3.2 Touch screen control	10
4. System elements	11
4.1 Marvelmind Autonomous Delivery Robots	11
4.1.1 Powertrain	11
4.1.2 Multi-shelves top	12
4.2 Marvelmind Indoor "GPS" system	13
4.3 Control system	14
5. Robot's controls and basic operations description	15
5.1 Controls	15
5.1.1 Bottom control panel	15
5.1.2 Top control panel	15
5.1.3 Break lever	16
5.2 Charging	17
6. Setting up the autonomous robots	18
6.1 What's in the box	18
6.1.1 Parcel 1: Disassembled Autonomous delivery robot without batteries	18
6.1.2 Parcel 2: Marvelmind batteries and charger	19
6.2 Assembling the robot	20
6.2.1 Robot's assembling	20
6.2.2 Battery connection	20
6.3 Test launch	22
6.4 Launching robots in the custom map	27
6.5 Marvelmind Robot's SW update	28
6.5.1 Encoder central board SW update	28
6.5.2 Robot's Raspberry board SW update	31
7. Contacts	33

Version changes

V2021_02_17

- Battery connection described
- Minor fixes and improvements

V2021_01_29

- Marvelmind Robot's SW update chapter described
- Launch robots in custom map chapter improved
- New delivery option described (One box)
- New assembling detail – collapsible vertical beams

V2020_10_09

- Testing SW link added (Test launch chapter)

V2020_09_24

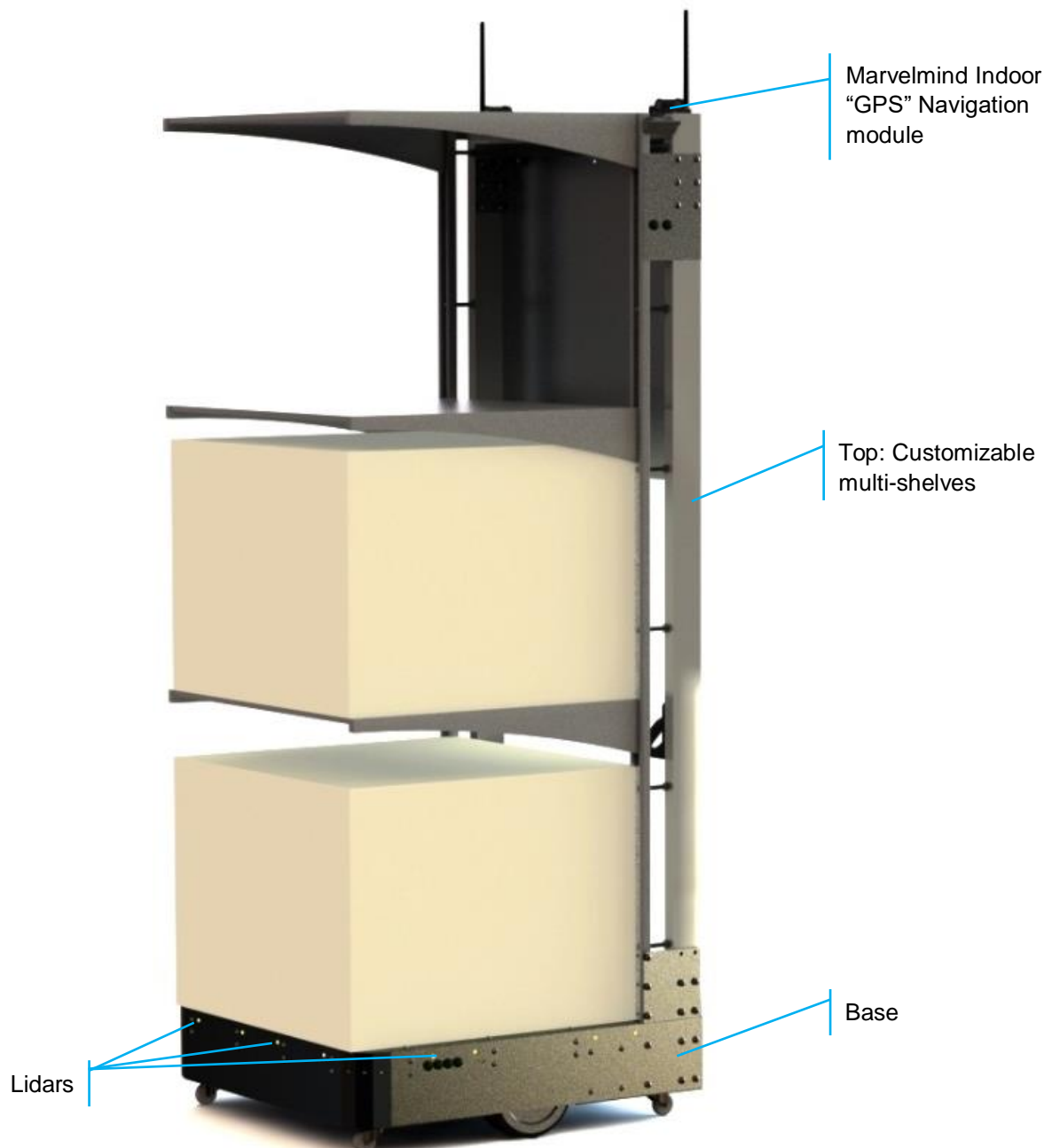
- Assembling the robot chapter described
- Testing launch chapter described
- What's in the box chapter improved

V2020_03_19

- Initial release

1. Executive summary

- Marvelmind Autonomous Delivery Robot is a fully autonomous, economically viable, and safe delivery robot of small-size goods for warehouse, retail and industrial applications
- Fully autonomous delivery between any points covered by Marvelmind Indoor "GPS"
- Up to 60kg payload. Tested with up to 80kg
- Driving time more than 16h on a single charge
- Automatic obstacle avoidance and detection
- The delivery route can be reconfigured by 1 button click in 1 second
- Charging time is less than 4h. So, 2-shift work (16h) and 1 shift (8h) charging is supported
- Re-configurable capacity: 1 large box of up to 65x65x160cm to up to 8 boxes of 65x65x15cm - one shelf vs. multiple shelves



- Up to 250 robots per system
- Reconfigurable multi-shelves top
- It is also can be equipped with QR-scanner to eliminate errors in the delivery of goods

Demo-video - [Autonomous Delivery Robot - car assembly plant demo](#)

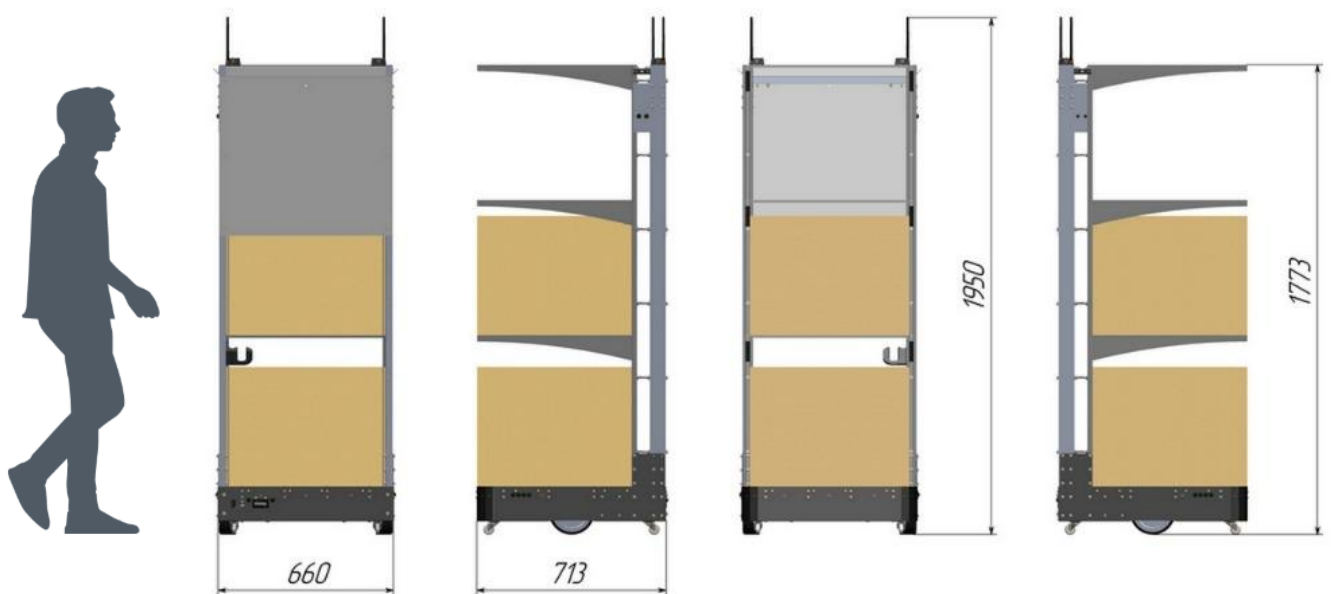


Demo-video - [Marvelmind v100 - cost-efficient autonomous delivery robot for intralogistics](#)







Key specs:

Parameter	Technical Specifications
Navigation	Marvelmind Indoor "GPS"
Top speed	7km/h
Payload	60kg
Driving time	More than 16h on a single charge with 60+kg payload
Charging time	Less than 4h with quick charger
Safety	Lidars for emergency stop and obstacle avoidance



1.1 Legend

Legend chapter contains small icons and signs to highlight some key points of the text.

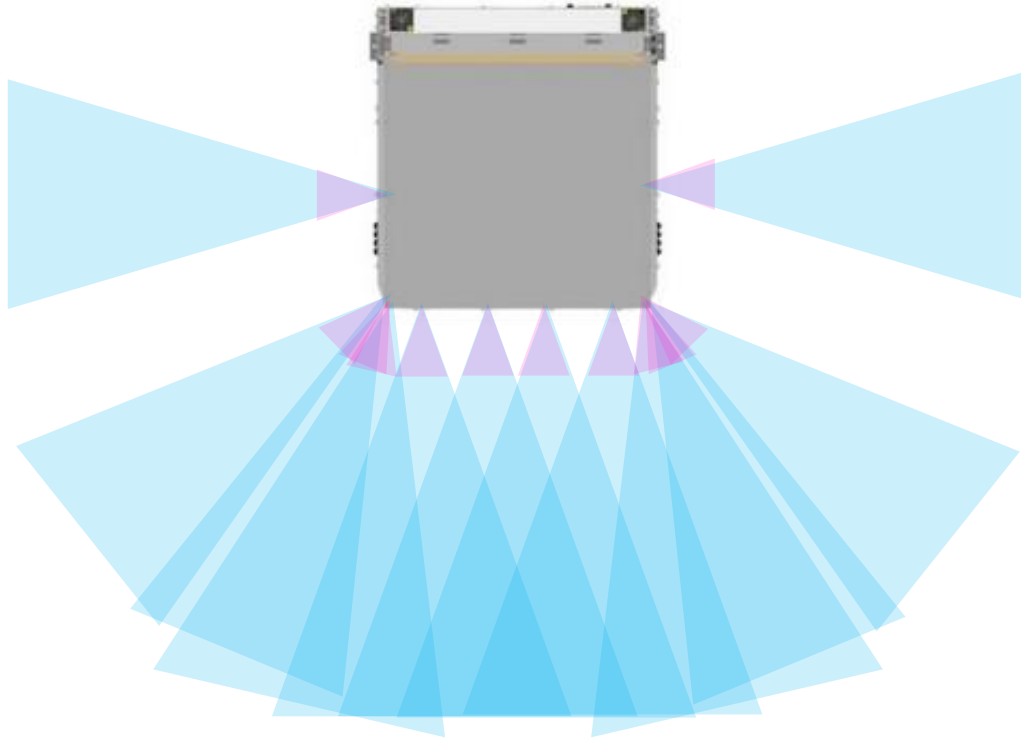
-  - Important
-  - For experienced users
-  - Demo or Help video
-  - Useful link

2. Robot's functionality

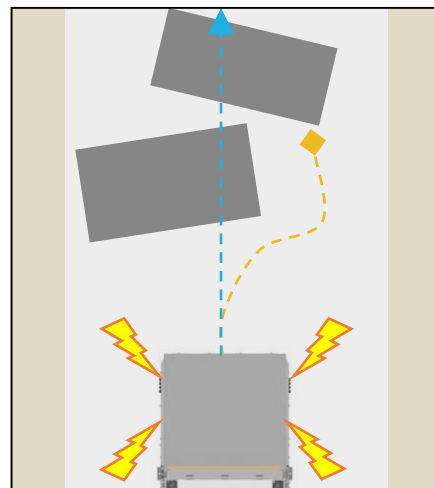
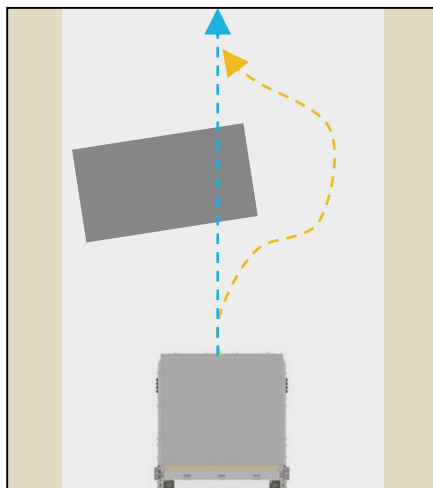
This chapter describes some key features of Marvelmind Autonomous Delivery Robot

2.1 Obstacle avoidance and detection

Marvelmind team installed multiple low-cost lidars into the robot to make it possible to be safety and guarantee solid coverage in different cases.



- Adjustable detection distance (0.3-4m)
- Emergency stop - <https://youtu.be/efOc-ltVvgg?t=67>
- Rebuilding paths and alarming if stuck



3. Robot's optional features

This chapter describes some additional parts and components which can be installed to the robot depending on your case. If you need something more, you can request some features you want to see in robot (contact info@marvelmind.com for details)

3.1 QR-scanner

QR-scanner placed in special convenient holder. It was added and smartly linked with robot's ECU. It can be added to decrease wrong deliveries and wrong goods placement.

Working order with Marvelmind QR-scanner algorithm:

- Robot gets a task. (To take goods with code 0021 for example)
- Robot reaches row and shelf with this good
- Worker take goods with code 0021 and scan it. If it's match – robot will start and go to its finish point
- If worker mixed goods and scanned good with code 0022, robot won't drive and will notify worker about the mistake. It also will write that mistake into CSV-file for future analysis
- Delivery complete

You can also use the scanner as a regular scanner, without strong bond to the Marvelmind Autonomous Delivery System.

3.2 Touch screen control

Touch screen gives advanced experience and control level of Marvelmind Autonomous Robots. It replaces and complements hardware buttons on the robot's housing.

What new abilities it gives:

- Displays information about current task
- Highlights goods code and delivery stage
- Displays statistics in real time
- Edit tasks and order
- Edit paths
- Displays whole map with robots and paths
- Other functions you may need (contact info@marvelmind.com for details)

4. System elements

4.1 Marvelmind Autonomous Delivery Robots

It relies on Marvelmind Indoor “GPS” navigation system. The robot is equipped with additional sensors for detecting and avoiding obstacles. It has a long battery life, high load capacity.

- Fully autonomous delivery unit from Marvelmind Robotics
- Can be flexible tuned with number of levels and cargos space
- Shockproof housing
- Bright lights
- Noticeable sound
- Programmable hardware buttons
- **Base** with multi-shelves **top** example:



4.1.1 Powertrain

Our team brought together capacious batteries, powerful motors and smart controllers in one device, making it budget and very productive.

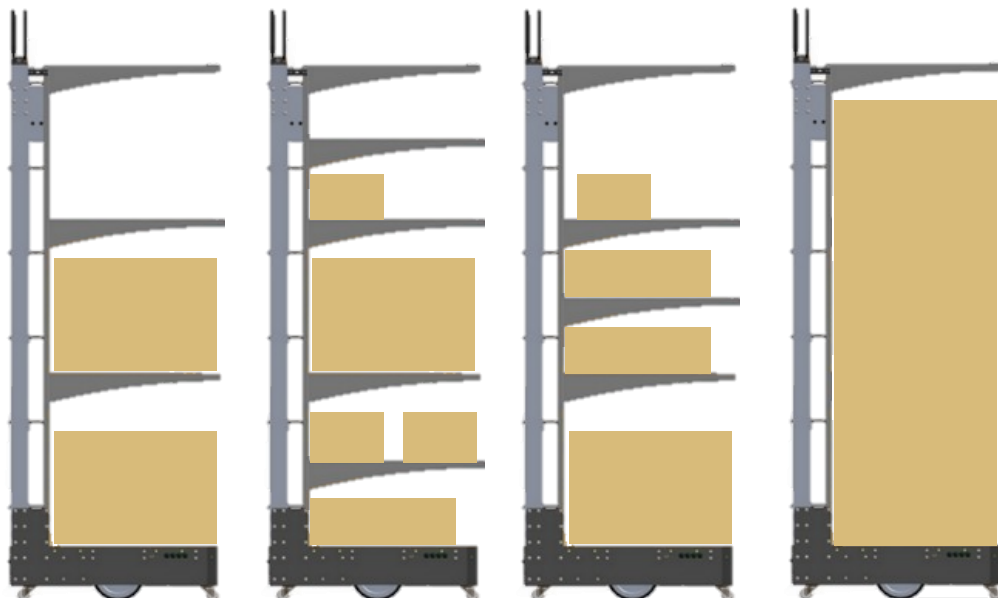
It gives the perfect balance between battery life and performance.

- Up to 16 hours driving with full payload of 60kg
- Emergency stops with breaks
- Suspension with smart weight distribution
- Recuperation (future optional)

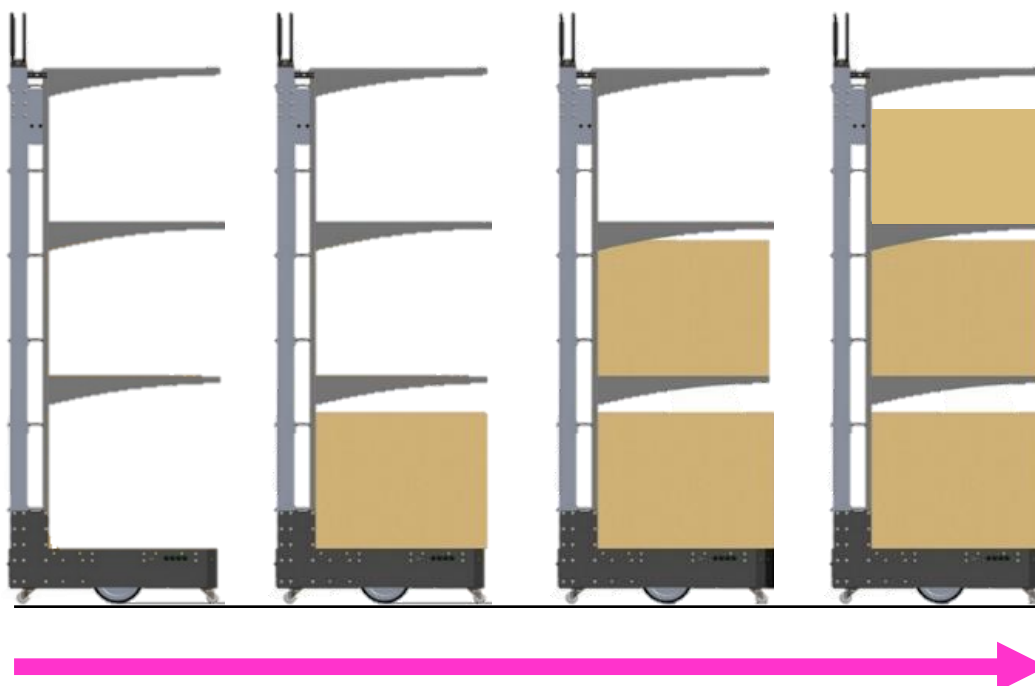
4.1.2 Multi-shelves top

Marvelmind delivery robot has customizable multi-shelf top. That means you can configure it as you need, it comes with 3 shelves in its base configuration. If you need more shelves – write to info@marvelmind.com.

- You can configure it as you need and change configurations in a minute.
- Up to 1650mm useful space height.



Loading cargo should be done starting from the bottom shelves ending with the top ones for correct weight distribution and avoiding a rollover



4.2 Marvelmind Indoor “GPS” system

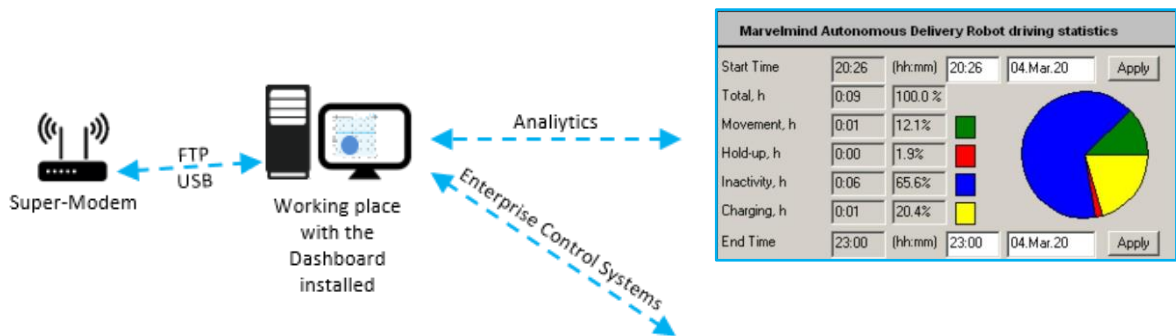
Marvelmind Indoor Navigation System is an off-the-shelf indoor navigation system, designed to provide precise ($\pm 2\text{cm}$) location data to autonomous robots, vehicles (AGV), and copters. It can also be used to track moving objects via mobile beacons attached to them. Other applications include, for example, forklifts, virtual reality (VR) systems, helmets for construction workers or miners, etc.

The navigation system consists of a network of stationary ultrasonic beacons interconnected via radio interface in a license-free band.



4.3 Control system

The control system allows you to configure the system, receive various data, collect statistics. The center of the control system is Dashboard. It communicates with the modem, receives data from it, and can send data in various formats.



5. Robot's controls and basic operations description

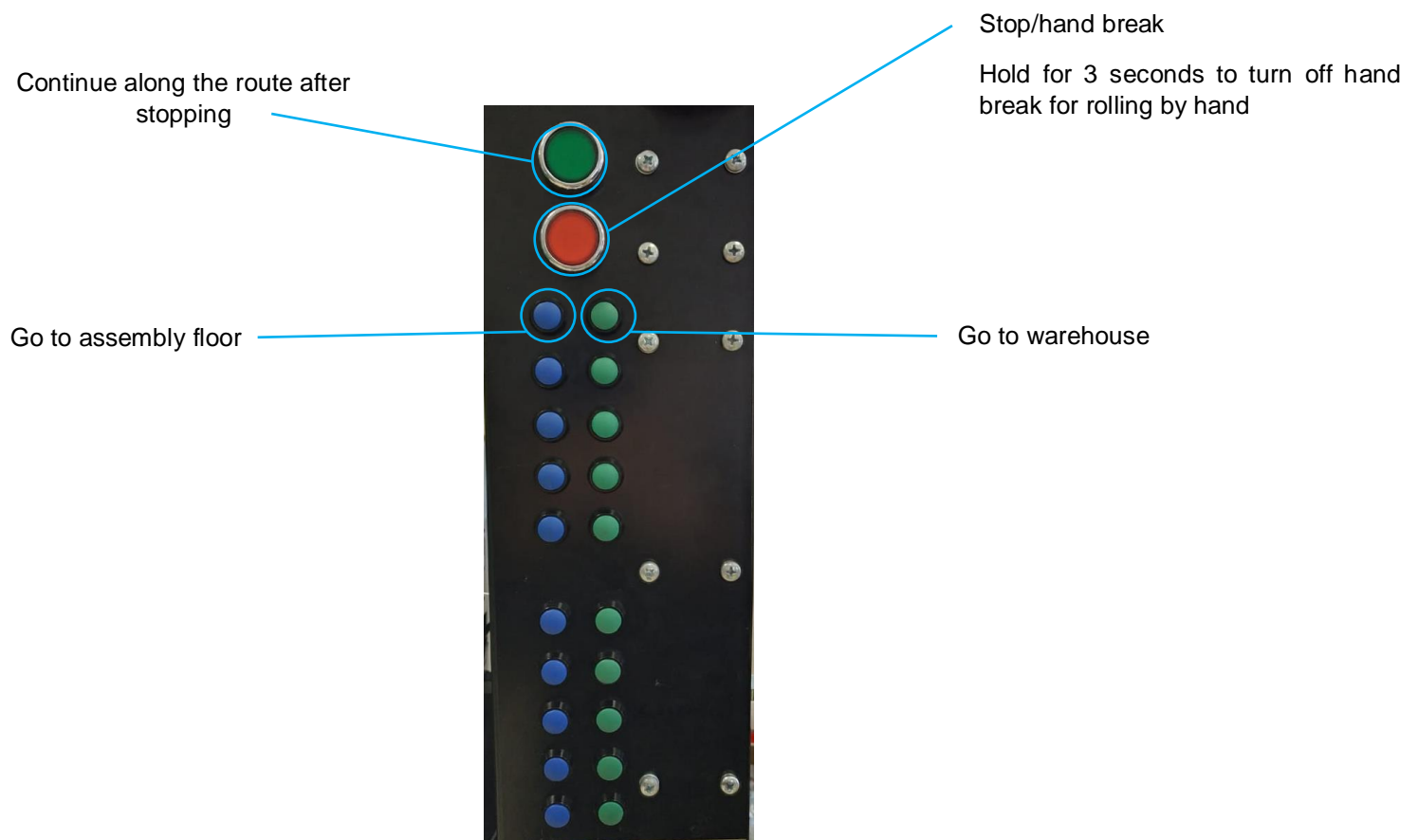
This chapter describes interactions with basic robot controls.

5.1 Controls

5.1.1 Bottom control panel



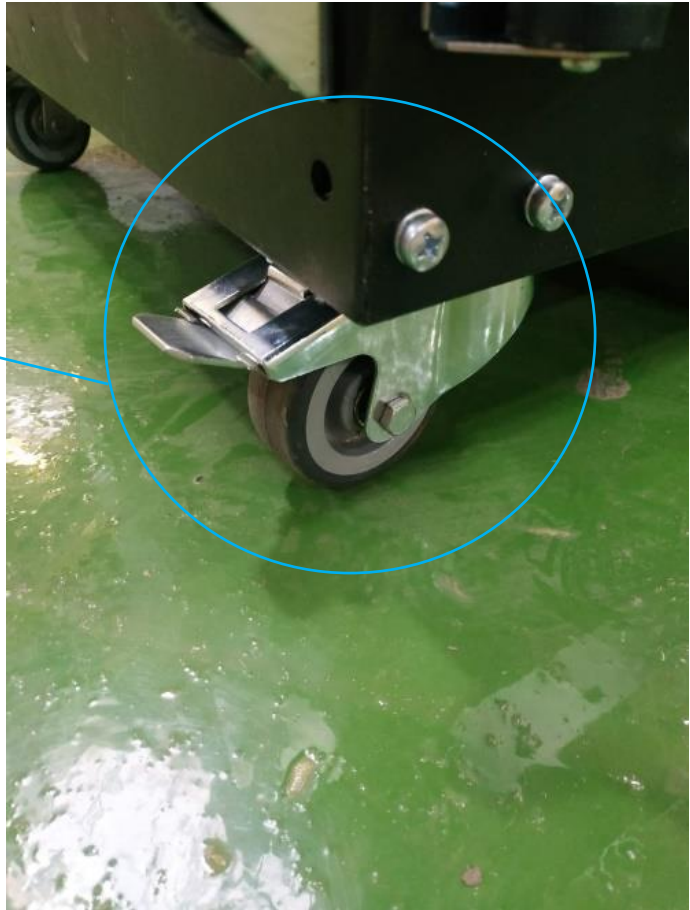
5.1.2 Top control panel



5.1.3 Break lever

Break lever (on each wheel)

Lower for long parking, storage, and charging. Lift before starting work.



5.2 Charging

Lower break levers and connect cable into charging port. Time until full battery is 5 hours.
Operating time at full battery is 16 hours.



Use only Marvelmind supplied chargers



Connect



6. Setting up the autonomous robots

The steps below describe setting up the system with Marvelmind Autonomous Robots.



Notice that Marvelmind Autonomous Robots relays upon Inverse Architecture.

6.1 What's in the box

This chapter describes contents of the box you receive buying the robot.

6.1.1 Parcel 1: Disassembled Autonomous delivery robot without batteries

Marvelmind Autonomous delivery robot comes in two parts: box with base and other parts and vertical beams or just in one box with collapsible beams (as shown on the pictures below)

How to assemble:

Help video: [Autonomous Delivery Robot v100 - assembly guide](#)

Option A: Box and vertical beams (Robots 01-05)



Option B: One box with collapsible beams inside (Robot 06 and newer)



6.1.2 Parcel 2: Marvelmind batteries and charger

Batteries and charger come in the second parcel.



Use only Marvelmind supplied chargers



6.2 Assembling the robot

First thing after receiving and unpacking the robot – assembling.

6.2.1 Robot's assembling

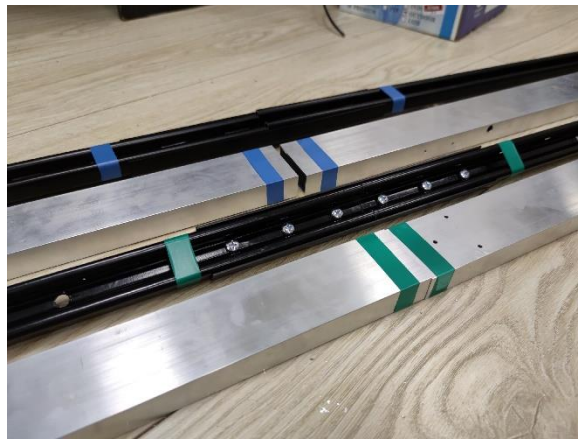
How to assemble:

Help video: [Autonomous Delivery Robot v100 - assembly guide](#)

Please notice that if you have **Robot 06 or newer**, it will come with collapsible vertical beams. One of the steps to assemble – to assemble vertical beams together. Do not switch sides (R and L), they marked with color duct tape to distinguish



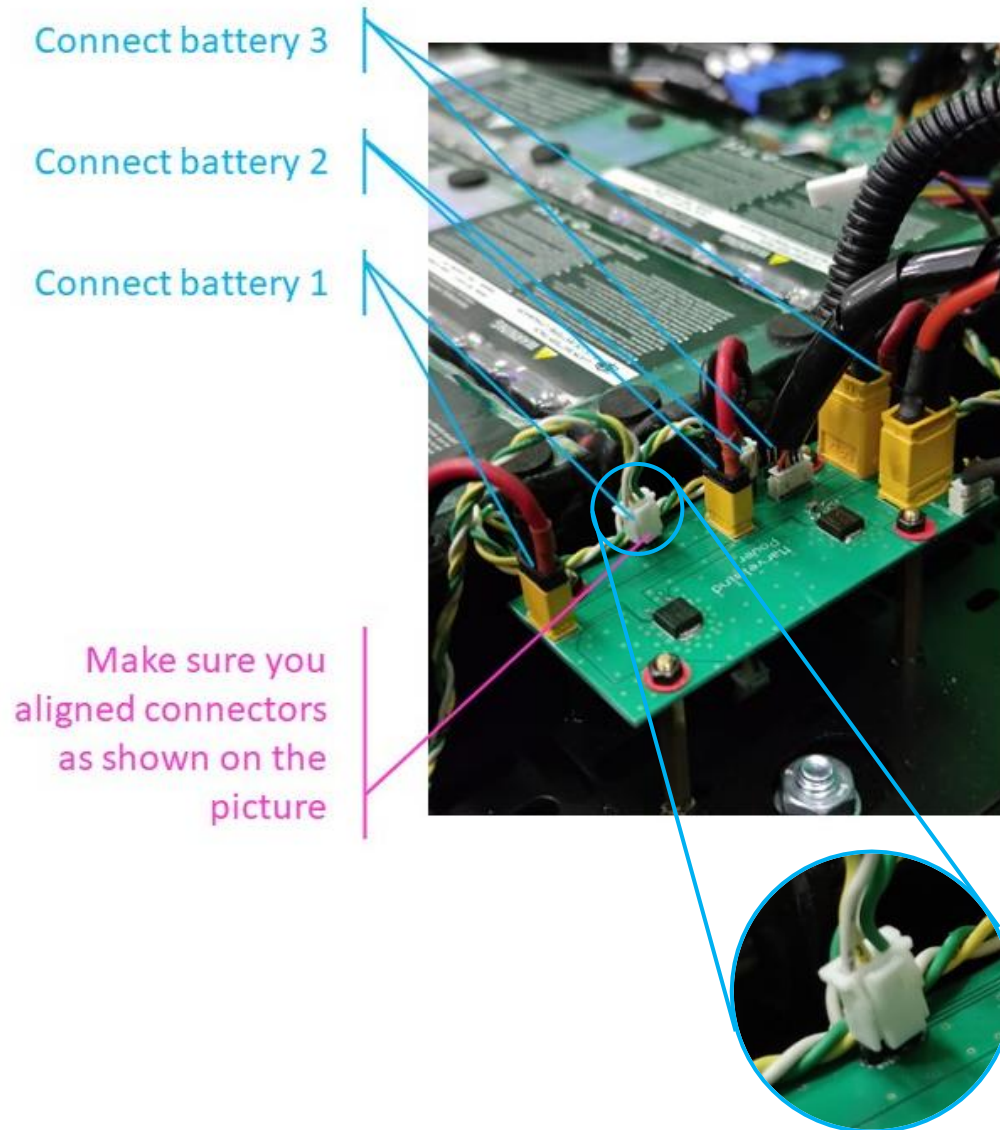
Pay attention to the position of the wires when assembling vertical beams. If they do not reach the connectors, move the wires



6.2.2 Battery connection

Connect batteries as described in the pictures below:





If you get any extra questions with assembling, you can write directly into info@marvelmind.com.

6.3 Test launch

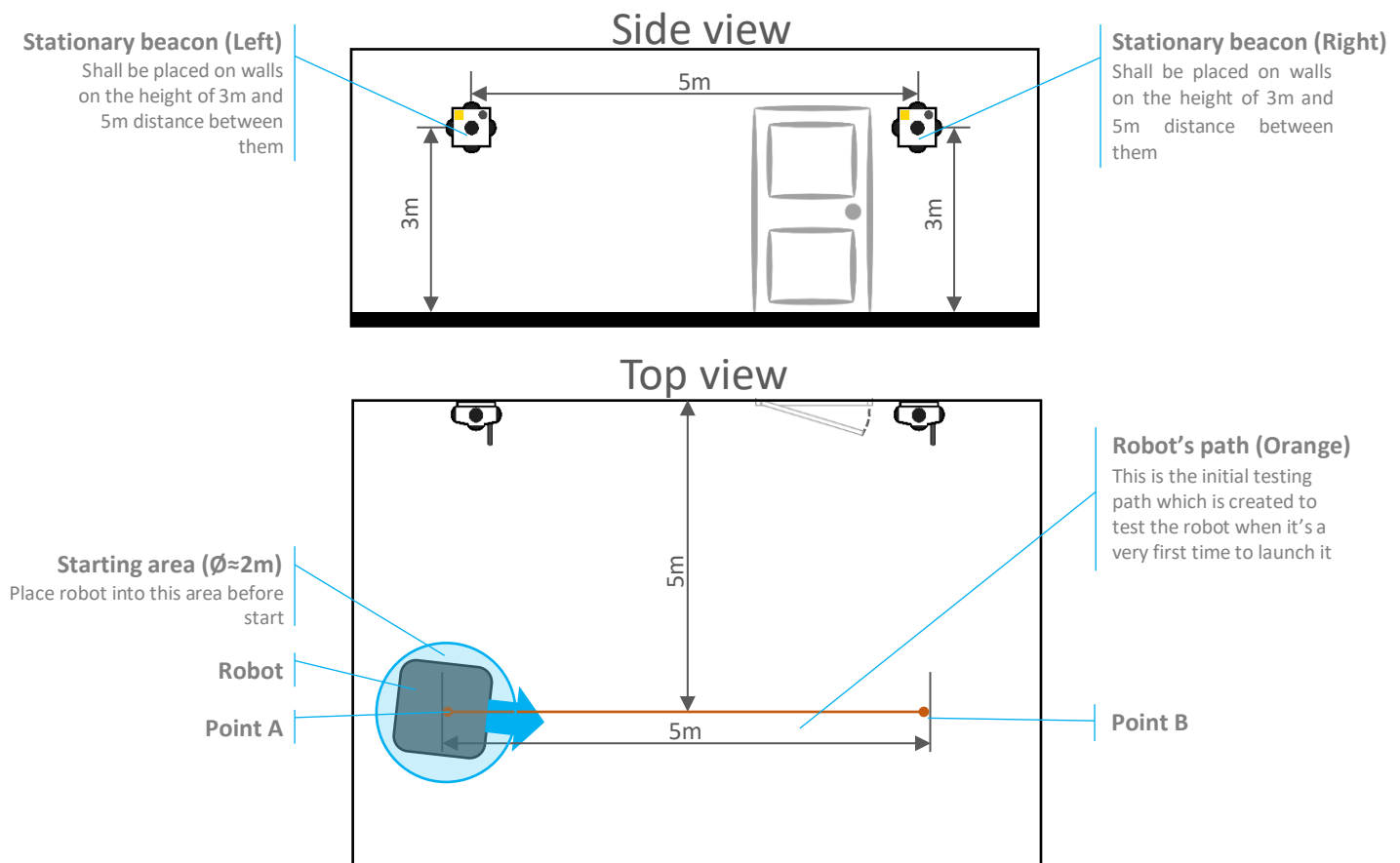
When you assemble the robot, you can start a testing launch process. Test launch is a process of testing for Autonomous Delivery Robot v100. Test launch consists of 5 autonomous rides from point A to point B and back. If you are experienced enough, you can skip this part and go forward to “Launching robots in custom maps” chapter.

When you received the Marvelmind Autonomous delivery robot, you also got 2 stationary Super-Beacons and Modem.

It is included to make it possible to do a test launch of the robot and ensure that the robot works correctly.

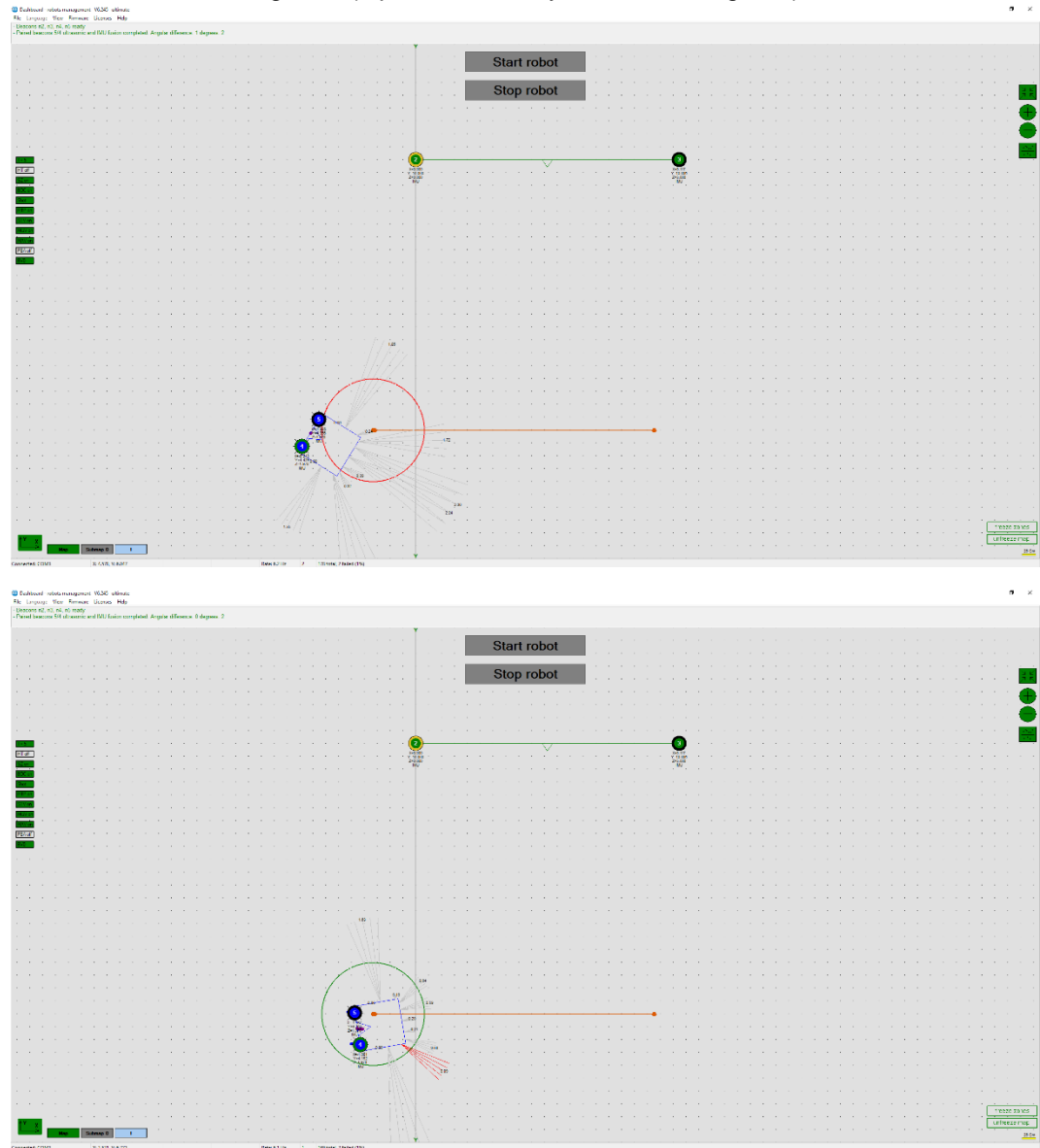
How to:

- 1) Place stationary beacons as described on the picture below



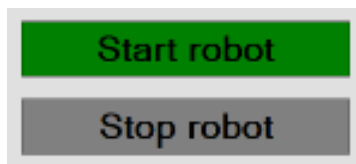
- 2) Install and launch [Marvelmind Robot Testing Dashboard SW](#)
- 3) Connect Modem to your PC via USB

4) Place robot into starting area (If placed correctly – area colors green)

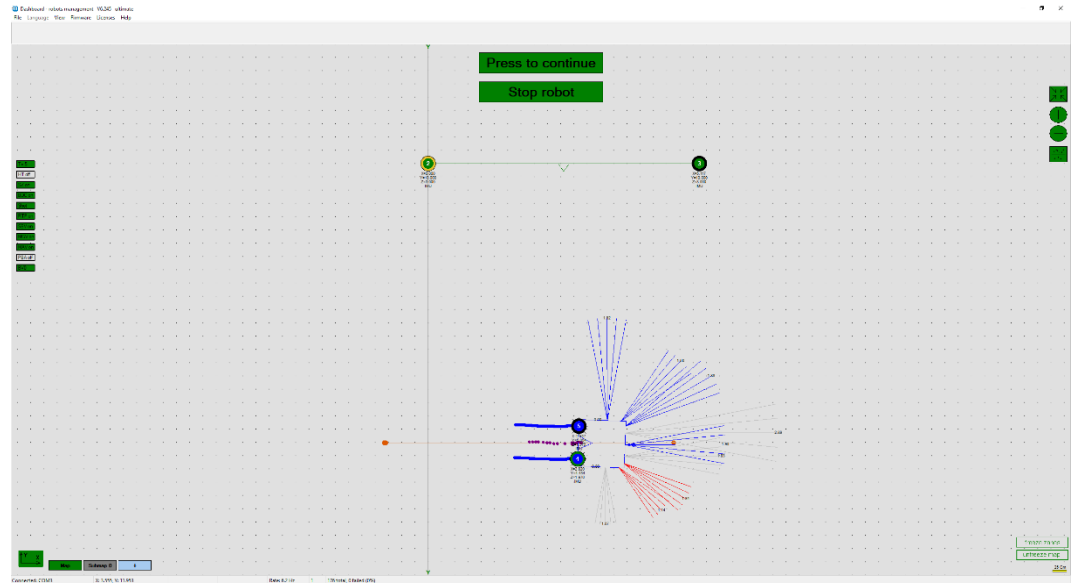


Make sure that you have enough space for the test launch.

5) When robot is ready to go and everything automatically checked by the system, “Start robot” button will color green



- 6) Press “Start robot” button to launch the robot
Robot will go through the testing path (from point A to B) and back five times



- To pause the movement – press “**Press to pause**” button while moving
- To continue the movement – press “**Press to continue**” button while stopped
- To stop the movement – press “**Stop robot**” button

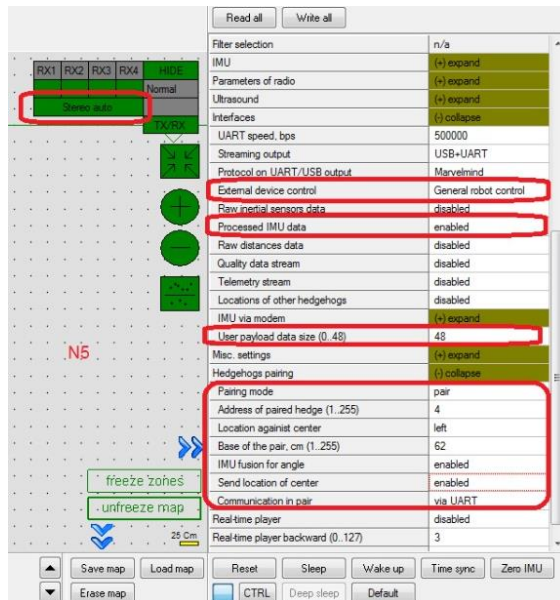
- 7) Test launch complete. Now, you can build your custom maps and launch the robot in it



Robots from the first batch (Robot 02 and Robot 03) come with not pre-flashed SW for stationary Super-Beacons. The initial steps before the test launch:

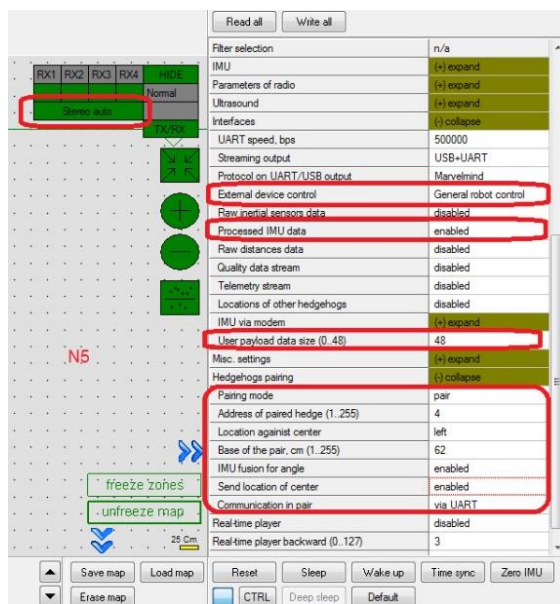
- 1) Flash left-side Super-Beacon on the robot via Dashboard (Open Dashboard -> Firmware -> Upload firmware), press Default button (In the right bottom corner) and apply following settings:

Read all		Write all
CPU ID	Copy to clipboard	013326
Firmware version		V6.192 Super-Beacon
Power save functions		enabled
Hedgehog mode		enabled
Inverse system		disabled
Distances only mode		disabled
Supply voltage, V		3.95
Desired speed, % (0..100)		30
Height, m (-320.000..320.000)		0.000
Time from reset, h:m:s		00:01:26 R
Measured temperature, °C		23
RSSI, dBm		-28
Radio frequency band		915 MHz
Center frequency, MHz		919.000
Device address (0..254)		5
Radio channel		0



- 2) Flash right side Super-Beacon on the robot via Dashboard (Open Dashboard -> Firmware -> Upload firmware), press Default button (In the right bottom corner) and apply following settings:

Read all	Write all
CPU ID	Copy to clipboard 013326
Firmware version	V6.192 Super-Beacon
Power save functions	enabled
Hedgehog mode	enabled
Inverse system	disabled
Distances only mode	disabled
Supply voltage, V	3.95
Desired speed, % (0..100)	30
Height, m (-320.000..320.000)	0.000
Time from reset, h.m.s	00:01:26 R
Measured temperature, °C	23
RSSI, dBm	-28
Radio frequency band	915 MHz
Radio frequency, MHz	910.000
Device address (0..254)	4
Radio channel	0



- 3) Flash left-side Stationary beacon via Dashboard (Open Dashboard -> Firmware -> Upload firmware), press Default button (In the right bottom corner) and apply following settings:

RSSI, dBm	-28
Radio frequency band	915 MHz
Center frequency, MHz	918.000
Device address (0..254)	2
Radio channel	0

- 4) Flash left-side Stationary beacon via Dashboard (Open Dashboard -> Firmware -> Upload firmware), press Default button (In the right bottom corner) and apply following settings:

RSSI, dBm	-28
Radio frequency band	915 MHz
Center frequency, MHz	918.000
Device address (0..254)	3
Radio channel	0

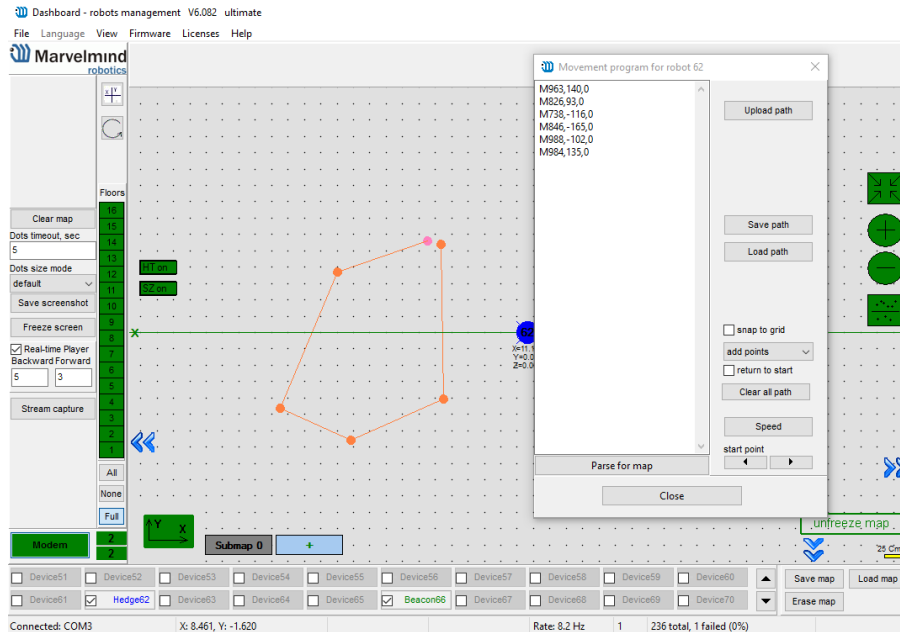
- 5) Flash Modem via Dashboard (Open Dashboard -> Firmware -> Upload firmware)
- 6) Now, continue with instructions given in the beginning of the chapter

6.4 Launching robots in the custom map

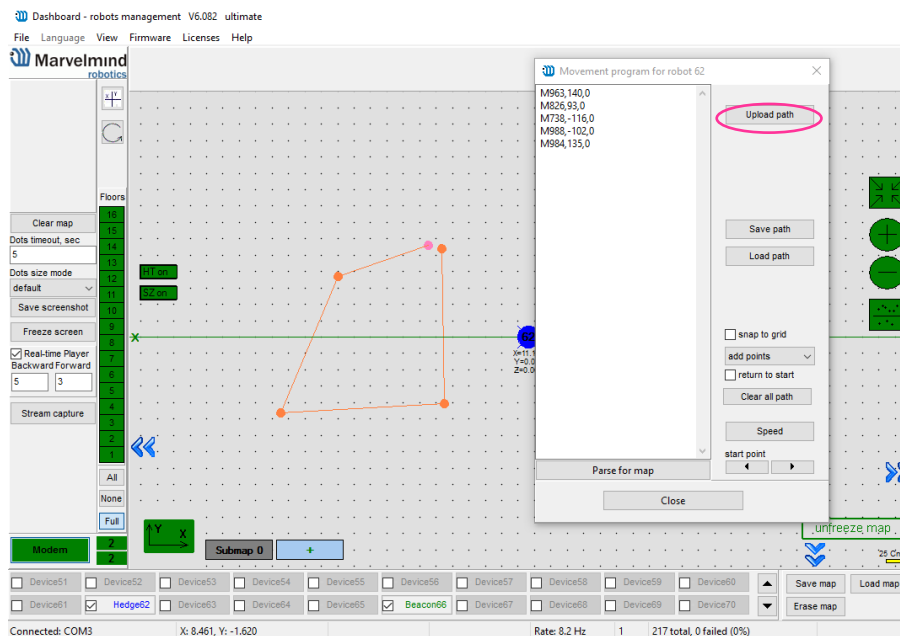
When you made a test launch of the robot and succeed, you can build more complex maps and launch the robot in it.

How to:

- 1) Set up the Marvelmind Indoor “GPS” system. It's detailed described in the [Operating Manual – Sending Path to Robot chapter](#)
- 2) Configure paths and start/end points (Use **Shift+Left mouse button click** to create point, click on point – to remove)



- 3) Upload path to robot (**Upload path** to send it to robot)



- 4) Reset the modem and connect it to the network.
- 5) Wait for 30 seconds after connecting (keep the modem and antenna vertically).
- 6) Position the robot on the driving zone/path.
- 7) Press the blue button (go to point 2 - end point).
- 8) After arrival at end point press the black button (go to point 1 - start point)

6.5 Marvelmind Robot's SW update

This chapter describes the SW update steps for Marvelmind Robot.



Please notice that you shouldn't do SW update just when you receive the robot. Do it if necessary

Latest Autonomous Delivery Robot v100 SW can be found in the marvelmind_robot_v100_SW file.



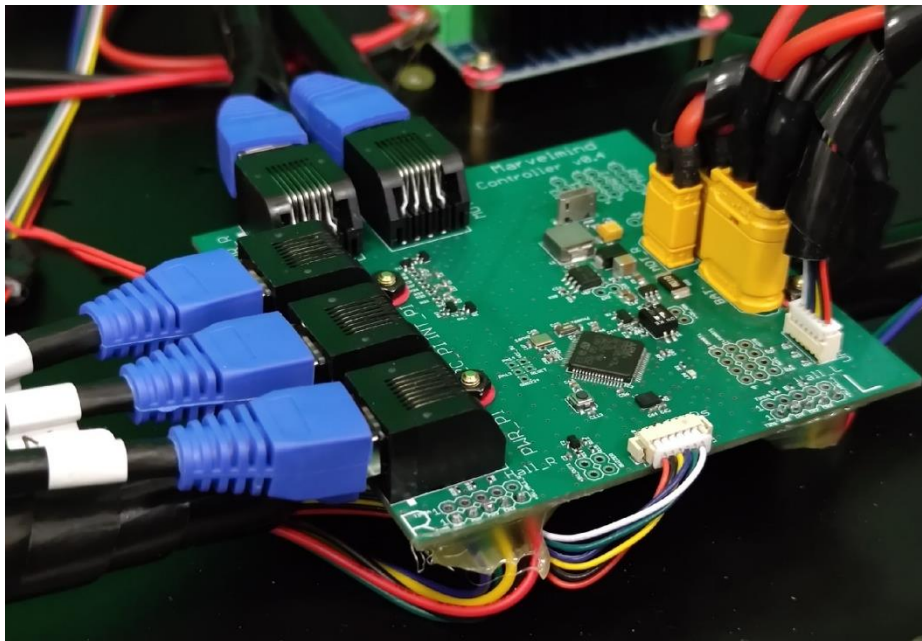
(If you have **Robot 08 and higher**, use the SW packs starting from **19.Jan.2021 and higher**), if you have **Robot 01-07** – use software pack **20.Dec.2020**)

SW update for the Robot consists of 2 parts:

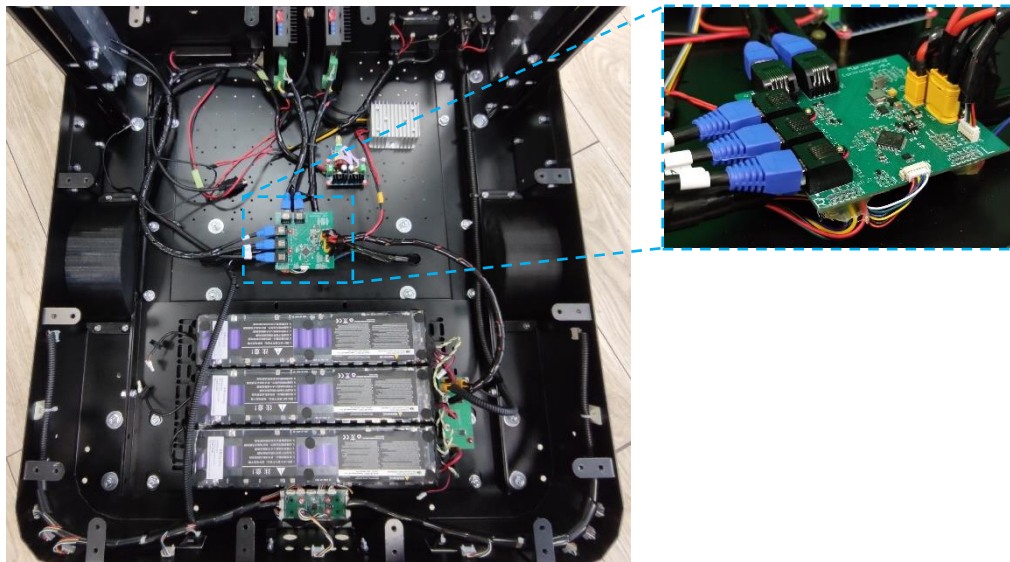
- 1) Encoder central board SW update
- 2) Raspberry board SW update

Follow instructions below to do an SW update for the Robot

6.5.1 Encoder central board SW update

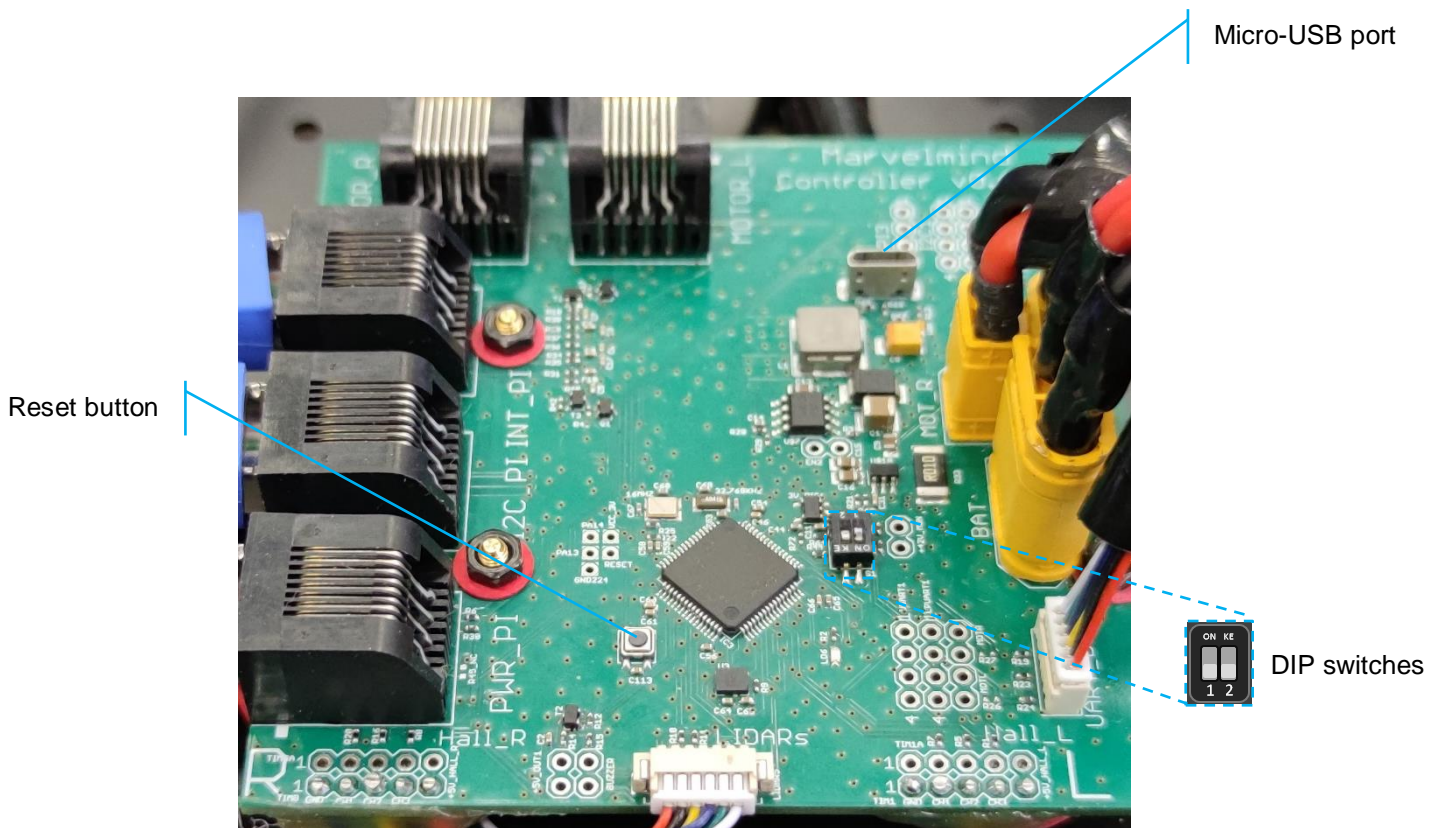


Encoder central board is placed in the Robot's base. To reach it, you should take off the top cover.



How to update:

Update for encoder board has the same principal as DFU update for any Marvelmind device.

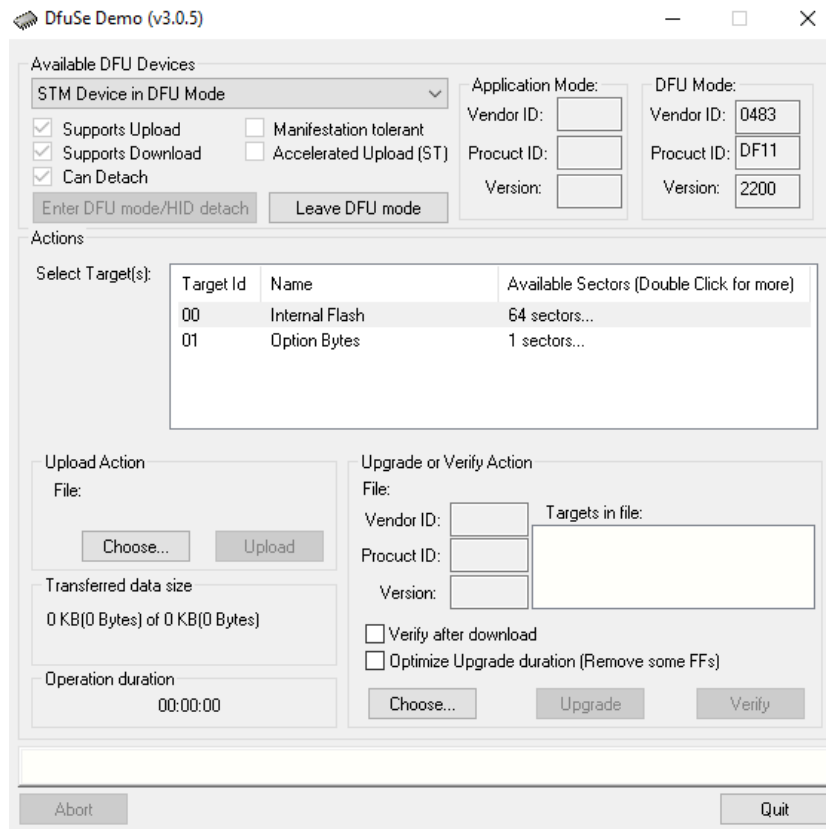


DFU Programming process:

1. Enter device into DFU Mode:
 - For Encoder board – switch DIP switches into positions shown on the picture (both up) and press the Reset button – device will go into DFU mode
2. Connect the device via USB to your PC
3. Run DfuSe (Choose whichever works the best for your Windows: [DfuSe v3.0.4](#) or [DfuSe v.3.0.5](#).)
4. In the upper left corner of the DfuSe program, you will see a device connected in the DFU mode (If not – reenter device into DFU mode).



5. Choose the DFU driver (file) for the Encoder board.
(marvelmind_robot_v100_SW_XXXX_XX_XX\marvelmind_robot_v100_firmware – robot_v100_encoder_board_v2.dfu)



6. Click the **UPGRADE** button.
7. After a couple of seconds, the DFU will be uploaded to the beacon. Make sure it takes 1–3 seconds and does not happen instantly. Otherwise, the SW has not been uploaded correctly. If the DFU appears to upload immediately, check the "Choose" button you used or change the version of DfuSe SW you selected.
8. Exit from the DFU mode:
 - For Encoder board – switch DIP switches into positions shown on the picture (Left – down, right – up) and press the Reset button – device will exit from DFU mode
9. DFU programming is complete.

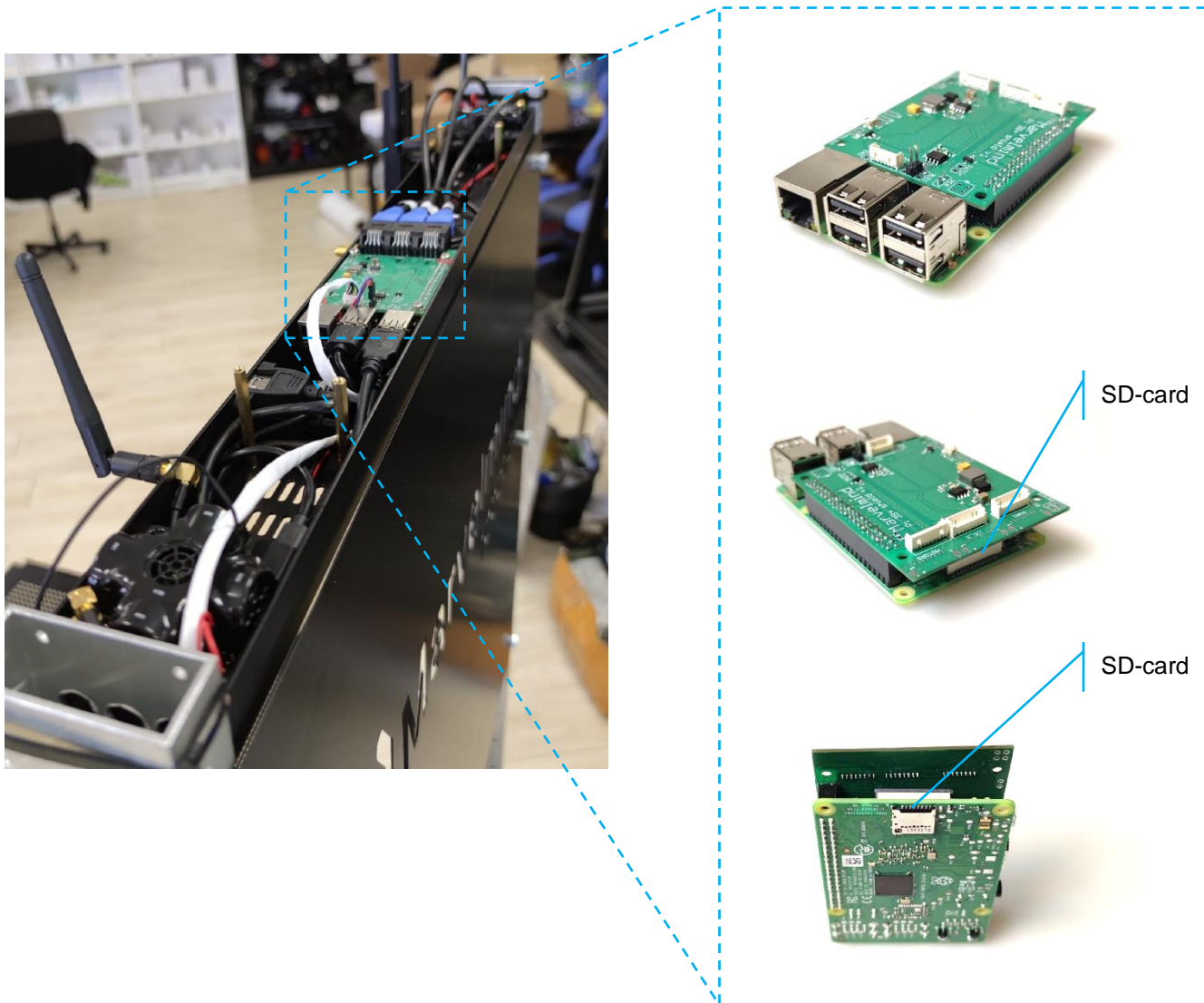


6.5.2 Robot's Raspberry board SW update

Robot's Raspberry board is situated in the top beam. To reach it – take of the cover.
SD card situated on the board, from the down side.



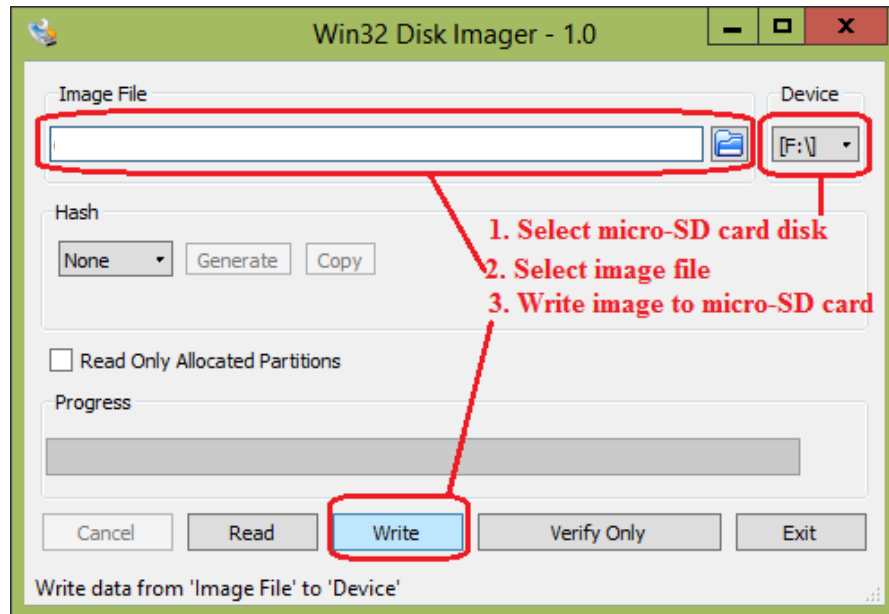
(If you have Robot 08 and higher, use the SW packs starting from 19.Jan.2021 and higher), if you have Robot 01-07 – use software pack 20.Dec.2020)



How to update:

1. Follow the steps below to update Raspberry's SW.
2. Eject the micro-SD card (Robot should not be powered at this time)
3. Insert micro-SD card into any MS Windows computer via card reader
4. Unpack the archive with image (included in the SW pack:
marvelmind_robot_v100_SW_XXXX_XX_XX\marvelmind_robot_v100_raspberry_firmware)
5. Install and run Win32 disk imager program (supplied in the archive with image)

6. Open the image file and write to the micro-SD card (see screenshot below)



7. Eject micro-SD card from computer and insert back into Robot's Raspberry
8. Robot's Raspberry board update complete.

7. Contacts

For additional support, please send your questions to info@marvelmind.com