Marvelmind Boxie

Operating manual

v2023_03_27

www.marvelmind.com

Contents

Version changes

V2023_03_27

- Chapter 5.5 updated. Updated information about Boxie display

V2022_09_06

- Chapter 5.8 Dashboard. Robot detailed settings updated
- Chapter 6.1 High-level robot control added

V2022_08_17

- Chapter 3 updated
- Minor improvements

V2022_08_12

- Section 1.1 What is the Robot Boxie used for added
- Section 3.6 Chassis. External interfaces added

V2022_08_10

- Minor improvements

V2022_06_23

- Chapter 2 updated
- Chapter 3 updated
- Section 4.3 moved to chapter 8
- Section 5.2 One-time flash for SW version from 7.000 added
- Section 5.3 Flashing via USB added
- Section 5.6 Robot detailed settings added
- Minor improvements

V2022_06_10

- Chapter 2 updated
- Chapter 5 updated
- Section 5.4 added

V2022_05_11

- Section 4.1.2 updated
- Section 4.3 added
- Section 4.4 added

V2022_04_19

- Section 1 updated
- Section 2.1 added
- Section 4 updated

V2021_08_05

- Multiple improvements

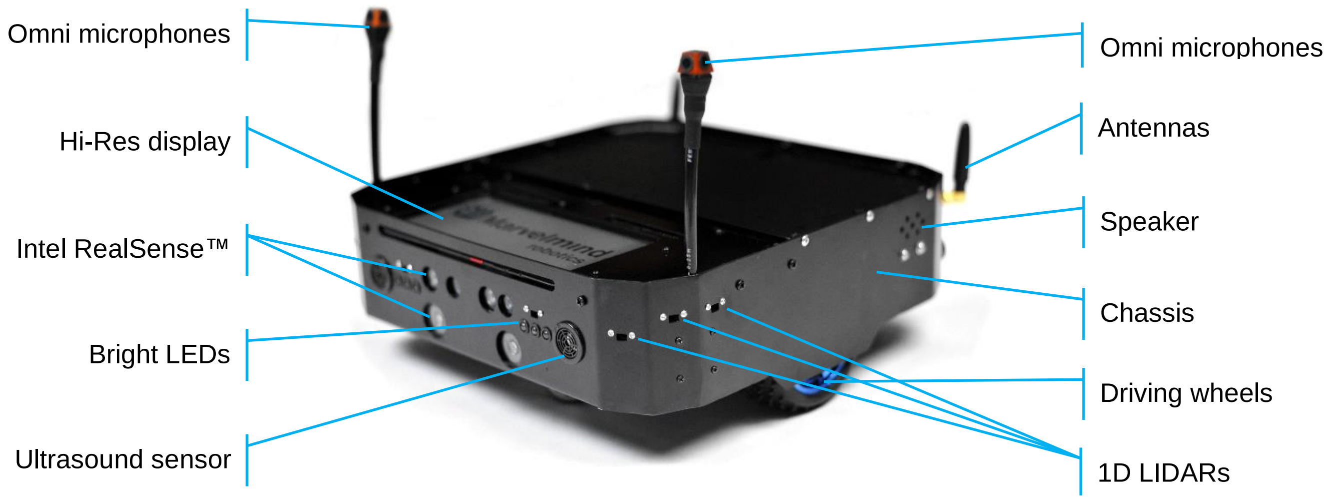
V2021_02_04

- Initial release

1. Executive summary

Marvelmind Boxie is an autonomous mobile robot designed for smart warehousing, industrial applications, research and education.

- Fully autonomous move between any points covered by Marvelmind Indoor "GPS"
- Payload capacity up to 10kg
- Driving time more than 8h on a single charge (no payload)
- Automatic obstacle avoidance and detection
- The route can be reconfigured by 1 button click in 1 second
- Charging time is less than 2h with Hi-current Marvelmind charger.
- Default charging time – 6 hours (with supplied charger by default)
- Smart screen for status display and interactions
- Up to 125 robots per system (today, much higher number in a future releases).



1) Demo-videos:

- Autonomous delivery robot Boxie and its inner beauty:-)
- Marvelmind Boxie – autonomous driving
- Fully autonomous drive by 2 robots – Marvelmind Boxie

Key specs:

Parameter	Technical Specifications
Navigation	Marvelmind Indoor “GPS” + Intel RealSense + LIDARs + Odometer + IMU
Top speed	2km/h
Weight	4.5kg
Payload	Up to 10kg
Driving time	Up to 8h drive with internal batteries (with no payload)
Charging time	- ≤2h hours with optional charger (Hi-power Marvelmind charger) - <6h hours (with supplied charger by default)
Sensors	- Marvelmind Indoor "GPS" for positioning. The system has been delive hundr projec worldv - Locati Directi based Marve precis positic syster - LIDAR - Intel RealS - Sever - Odom each v - 12 x 1 LIDAR - Sonar - Currer sensir

1.1 Robot Boxie. Typical use cases.

Marvelmind Boxie is an autonomous mobile robot designed for smart warehousing, industrial applications, research and education.

Learn more in this video:

[Boxie - autonomous robot - detailed (33'40'') review]

1.1.1 Autonomous delivery

Autonomous delivery of goods or baskets with goods/tools/inventory in warehouses, assembly plants (expensive gauges and similar), chemical plants (samples, etc.).

Check the video:

Autonomous robot Boxie carries up to 10kg

1.1.2 Inspection

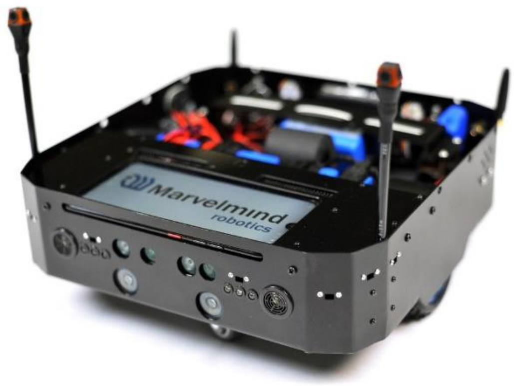
Autonomous (daily, nightly, hourly, etc.) inspection with optional cameras and additional measurement devices:

See an example in this video:

[Autonomous driving - basic demo]

1.1.3 For education and research:

Good for Universities.



See an example in this video:

[How autonomous robots keep driving so precise?!]

1.2 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. What's in the box

There are 3 types of Boxie configuration:

- Basic – the same as standard, but doesn't have Intel RealSense
- Standard – optimal Boxie configuration with RealSense
- Advanced – configuration with 2 batteries, Hi-current Marvelmind charger, RealSense and Starter Set Super-MP-3D. Also includes extended warranty

	Basic	Standard	Advanced
Autonomous robot	Yes	Yes	Yes
Charger 1A	Yes	Yes	Yes
RealSence (D435+T265) + software	Not included	Yes	Yes
Dedicated Zoom training, hours	Not included	1	5
Super-Beacon + Modem HW v5.1 included, pcs	Not included	Not included	5+1
High current charger (5A)	Not included	Not included	Yes
Extended warranty	Not included	Not included	Yes

2.1 Basic configuration

- Robot Boxie Basic
- Charger 1A

2.2 Standard configuration

- Robot Boxie Standard
- Charger 1A

2.3 Advanced configuration

- Robot Boxie
- Charger 1A
- High current Marvelmind charger (5A)
- Extended warranty
- 5 x Super-Beacon
- 1 x Modem HW v.5.1

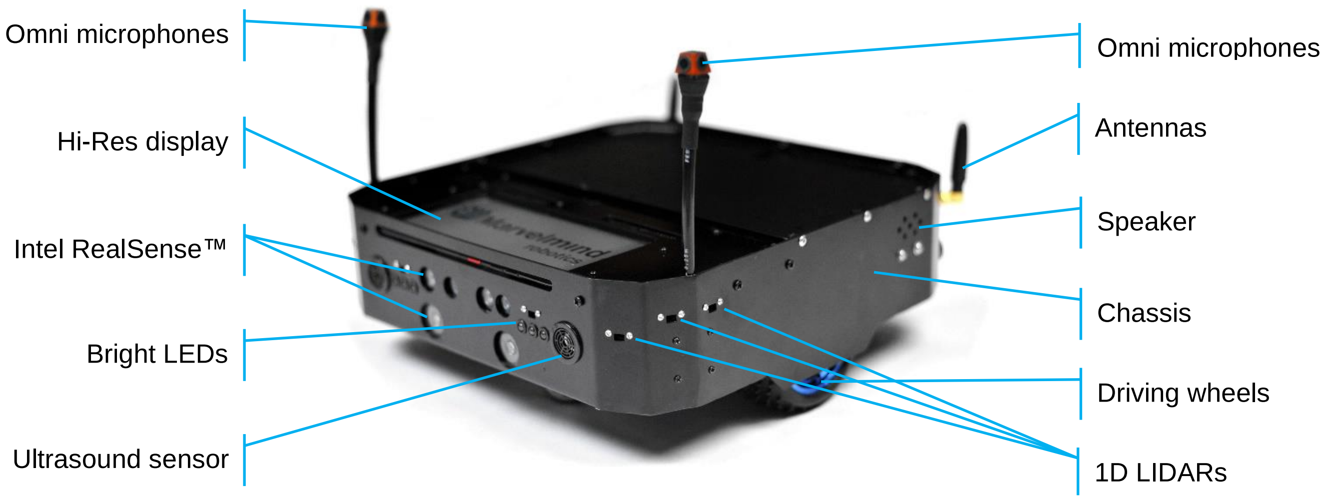
-

3. Hardware system elements

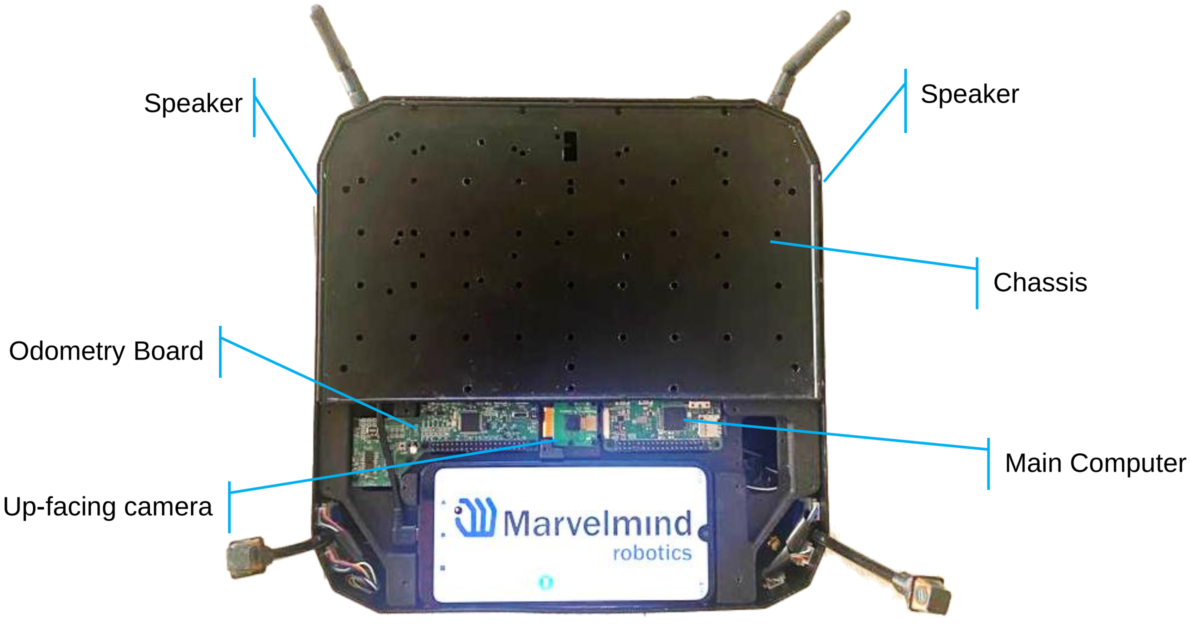
In this chapter are represented core elements of Marvelmind Boxie. What included in Marvelmind Boxie, how it looks like, how it works, how to use it.

In this chapter you will get acquainted hardware part of the robot.

Side view:



Top view:



Check the video: Boxie - autonomous robot - detailed (33'40") review

3.1 Powertrain

Key specifications:

- 2 motor-wheels with odometer
- 2 castor-wheels

3.2 Marvelmind Indoor “GPS”

Marvelmind Indoor Navigation System is an off-the-shelf indoor navigation system, designed to provide precise (±2cm) 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, one or more mobile beacons installed on objects to be tracked and modem providing gateway to the system from PC or other computers.

Mobile beacon’s location is calculated based on a propagation delay of an ultrasonic pulses (Time-Of-Flight or TOF) between stationary and mobile beacons using trilateration algorithm.

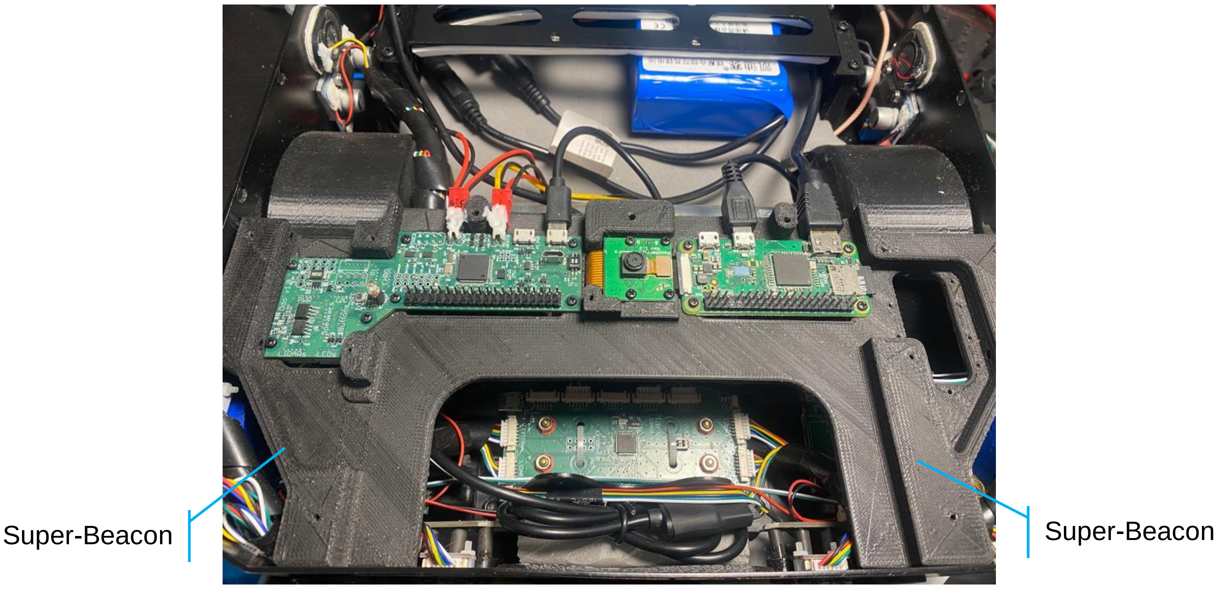
The system can build the map of stationary beacons automatically. In simple cases, no additional manual data input or any manual distance measurements are required. This map formed once can be frozen and stored in modem’s memory and the system becomes fully active within 7 to 10 seconds after the modem is powered.

In the Robot Boxie it instilled for ultrasound tracking.

3.2.1 Modificated Super-Beacons

In Robot Boxie Modificated Super-Beacons connected to HUB that connected to main computer and work as mobile beacons.

Each Super-Beacon connected with Full size antenna and Omni microphone. Omni microphone can be extended up to 1m (optional).



3.2.2 Full size antennas

Connected to Modificated Super-Beacons, using for Marvelmind radio in license-free band (868 or 915MHz).

3.2.3 Omni-Microphone-IP67

Omni-Microphone-IP67 is an advanced all-directions microphone for robots and forklifts when the highest performance and the largest submaps are required.

- Omni-Microphone is an external microphone that can be used along with Super-Beacons and Mini-RXs. On request, it can also be used along with Industrial-RX and Industrial Super-Beacons. The later support in HW and SW, but additional modification of housings is required
- It has a super-wide 360×360-degree beam, i.e. Omni-directional pattern
- It is possible to enable and receive signal from any of the microphones separately, thus, to disable a noise source from an unwanted direction, because the Omni-Microphone consists of 4 external microphones back to back
- The Omni-Microphone is great for Direction + Location, for example, for robot's
- It is highly recommended for larger submaps (25m+) or when a particularly guaranteed and robust tracking of a forklift or similar mobile object on the largest possible distance. See video below for more info about microphone diagrams
- The microphone is IP67 protected by special membranes and compound
- The microphone requires soldering. There are easy to use pins on the board and connectivity is described in the Operating Manual
- Only one Omni-Microphone can be connected to a Super-Beacon or to a Mini-RX, because, effectively, there are four microphones inside already
- The default cable length is 20-25cm. Optionally, it is possible to have the Omni-Microphone with up to 1m-cable
- By default, the microphone is shipped with a 2mm-flexible cable ready for soldering. On request, it can be supplied with a flexible mounting tube for easy installation on a forklift or a robot – "antenna-like configuration". Let us know about your preferences and the desired length when ordering. There are other mounting options as well

3.3 Intel RealSense (Available in Standard and Advanced configurations)

Inter RealSense gives additional functionality of positioning and safety if somehow Marvelmind Indoor "GPS" isn't available in some scenarios:

What new abilities it gives:

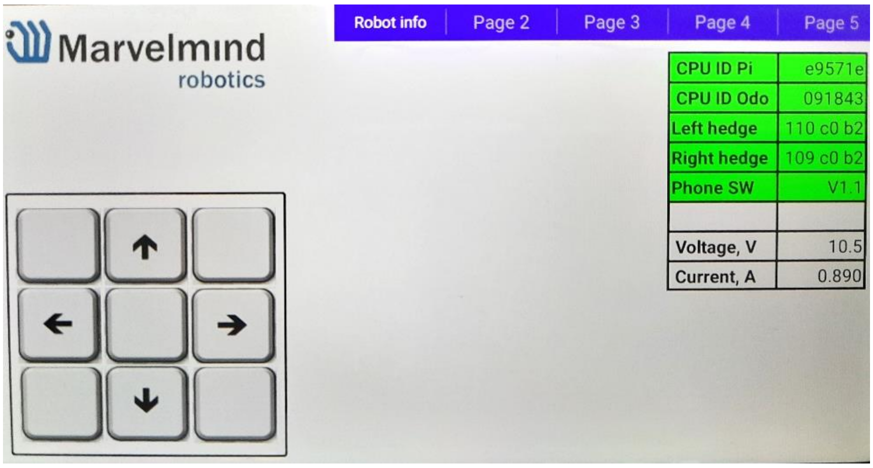
- Additional safety by Intel RealSense
- Addition option of positioning through Intel RealSense
- Other functions you may need (contact info@marvelmind.com for details)

3.4 Touch screen control

Touch screen gives advanced experience and control level of Marvelmind Boxie. It complements hardware buttons on the robot.

What new abilities it gives:

- Displays information about Boxie.

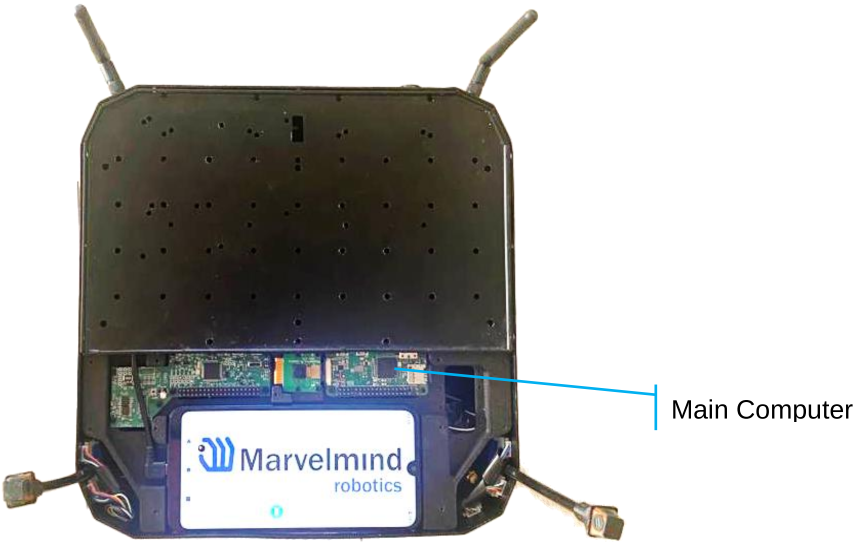


- Displays information about current task (Future stage)
- Highlights goods code and delivery stage (Future stage)
- Displays statistics in real time
- Edit tasks and order (Future stage)
- Edit paths (Future stage)
- Displays whole map with robots and paths (Future stage)
- Other functions you may need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

3.5 Main Computer

Main computer supports:

- Bluetooth
- Wi-Fi
- SD card
- 40pins of Pi Zero – standard interface
- 1GHz single-core CPU
- 512MB RAM
- Mini HDMI port
- Micro USB OTG port
- Micro USB power
- HAT-compatible 40-pin header
- Composite video and reset headers
- CSI camera connector (v1. 3 only)



3.5.1 Bluetooth

Bluetooth allows communication with external devices. Supports by hardware.

Software related will be provide in future update.

3.5.2 Wi-Fi

Wi-Fi is used for fast data transfer, for debugging, for transfer of volume data, for example – visual data. For obstacle detection, image recognition and similar tasks.

(Supports by hardware. Software related will be provide in future update.)

3.5.3 Mini HDMI port

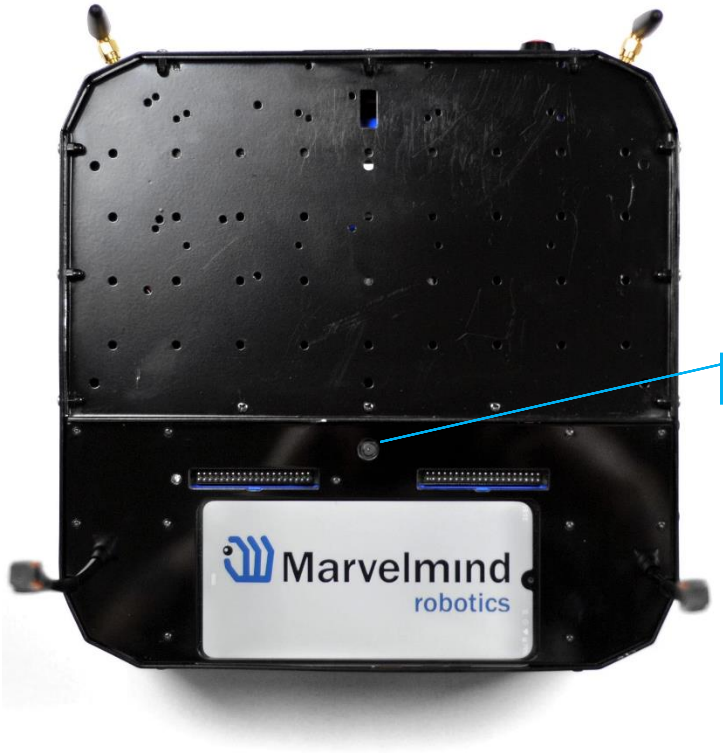
HDMI port is another part of the main computer, using to connect a screen.

HDMI port. Can be used to connect a screen

The HDMI port is moved on the outer part of the robot in the form of a classic HDMI connector, for simple use.

3.5.4 Up-facing Camera

CSI camera connector (v1.3 only). The Raspberry Pi Camera Board plugs directly into the CSI connector on the Raspberry Pi.

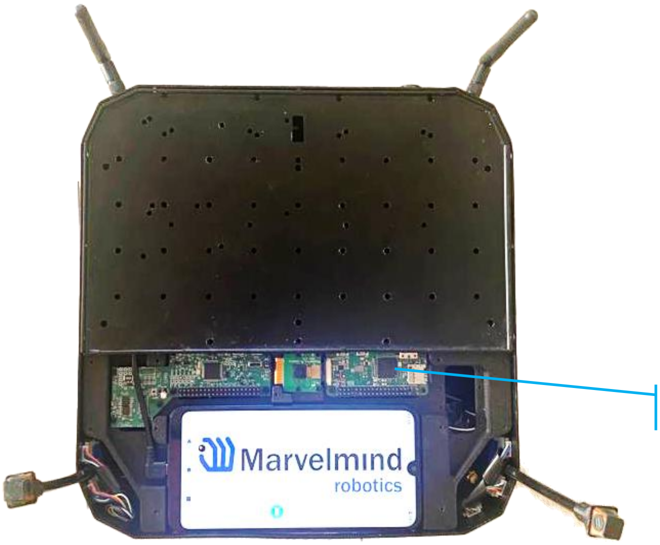


Up-facing camera

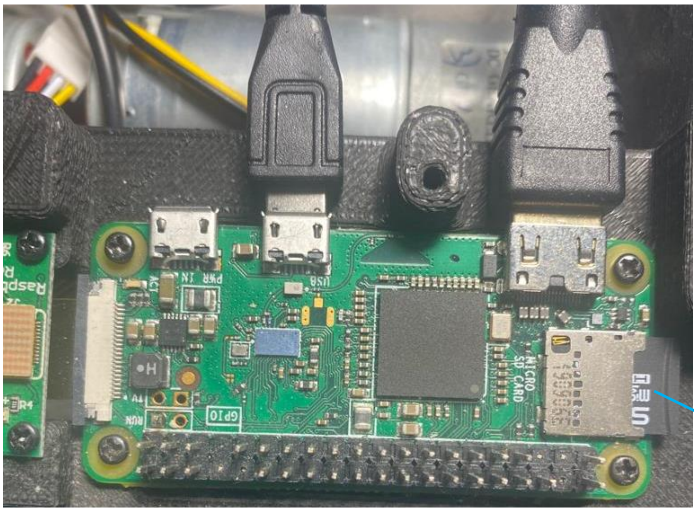
It's using for star-gazing tracking, real time QR tracking or nature positing of a robot. It's not as precise as ultrasound tracking and RealSense tracking, but also can be used.

3.5.5 SD Card

SD card inserted into the main computer. Mostly using for [SW Pack] and programming. But also can be used to store various data.



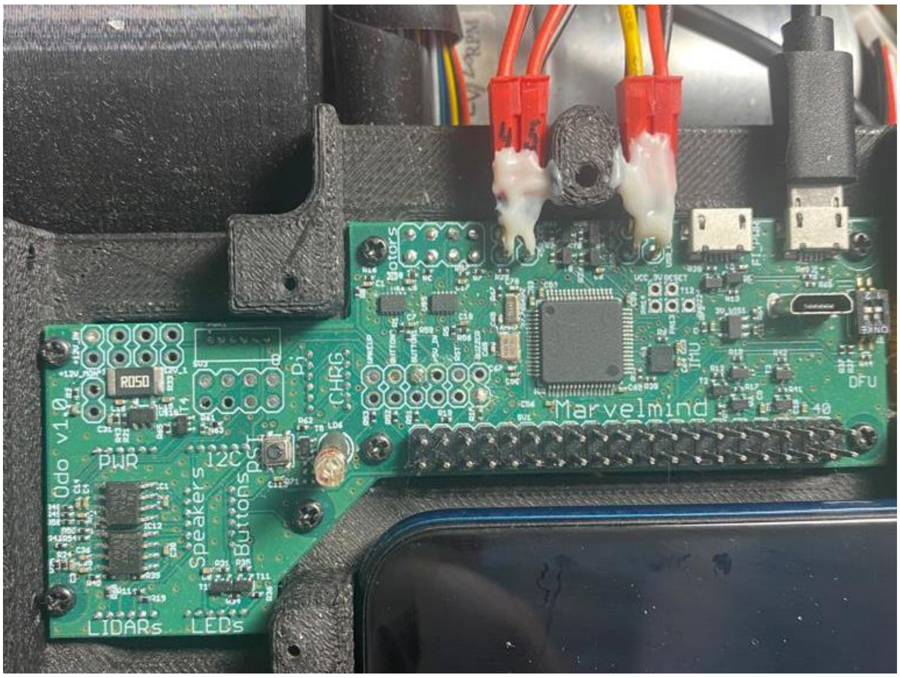
A 16GB SD card with preinstalled software is supplied with the Robot Boxie.



3.6 Odometry board

Odo board stands for Odometry board. It takes low level operations that are too fast for a main computer.

Odo controls the motor controllers. A special processor helps to process data and motion algorithms and controls motors.



Also on it are the components responsible for lighting, for obstacle detection control and LIDAR board.

Contains keys for external devices control:

- To turn on
- Turn off and
- Power supply.

40 pins from our Odometer board:

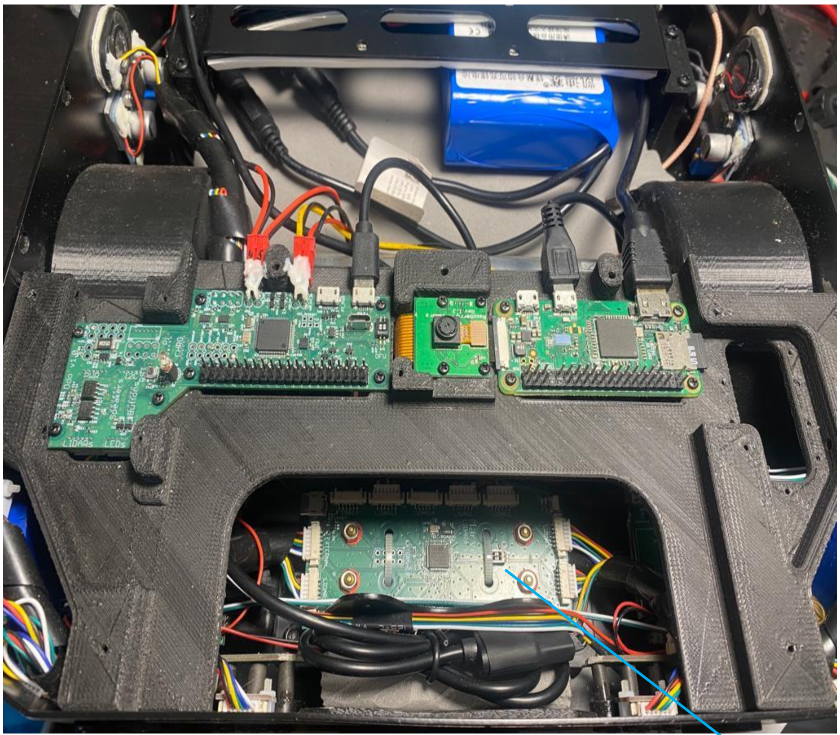
- UART (allows you to connect directly to the board, bypassing the main computer)
- SPI
- I2C
- USB
- GND switch, +12V & 1A and +5V & 1A to power your external devices

3.7 LIDARs and LIDAR board

This section describes connections and placement of LIDAR system. This system provides an obstacle detection function (read more in Obstacle detection and avoidance).

3.7.1 LIDAR board

LIDAR board uses to connect all LIDARS. Connected to HUB that connected to main computer of the Boxie.

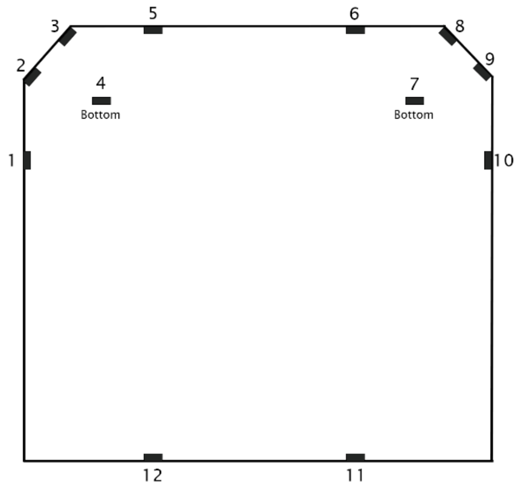


LIDAR board

Board controls via Odo board.

3.7.2 LIDARs

LIDARs are located around the perimeter, each of them has viewing angle up to 27 degrees.



LIDARs only react on objects that reflect infrared light in a distance up to 4 meters. It can't be use to avoid clear glass.

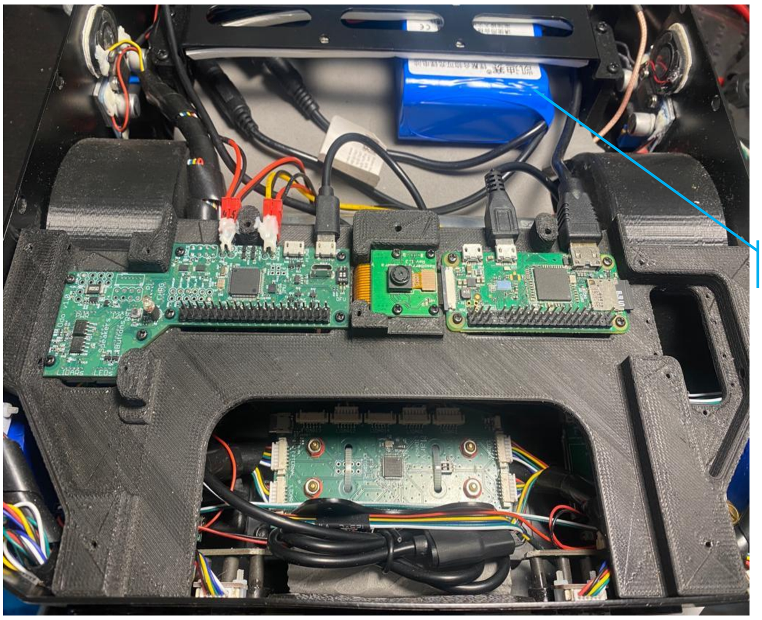
To avoid false alarms, this distance is limited to a meter, which allows the robot to stop and decide to avoid obstacle.

3.8 Battery and Chargers

Boxie is equipped with a Li-ion polymer battery.

3.8.1 Battery

- 12V-battery with different internal capacity from 40Wh to 100Wh
- Default 1A charger and optional 5A (10A) fast charger
- Optional external batteries
- Current and voltage sensing (also available via API)



Robot Boxie has 2 charger ports:

- For 1A charger
- For High current Marvelmind charger (5A)

3.8.2 Charging

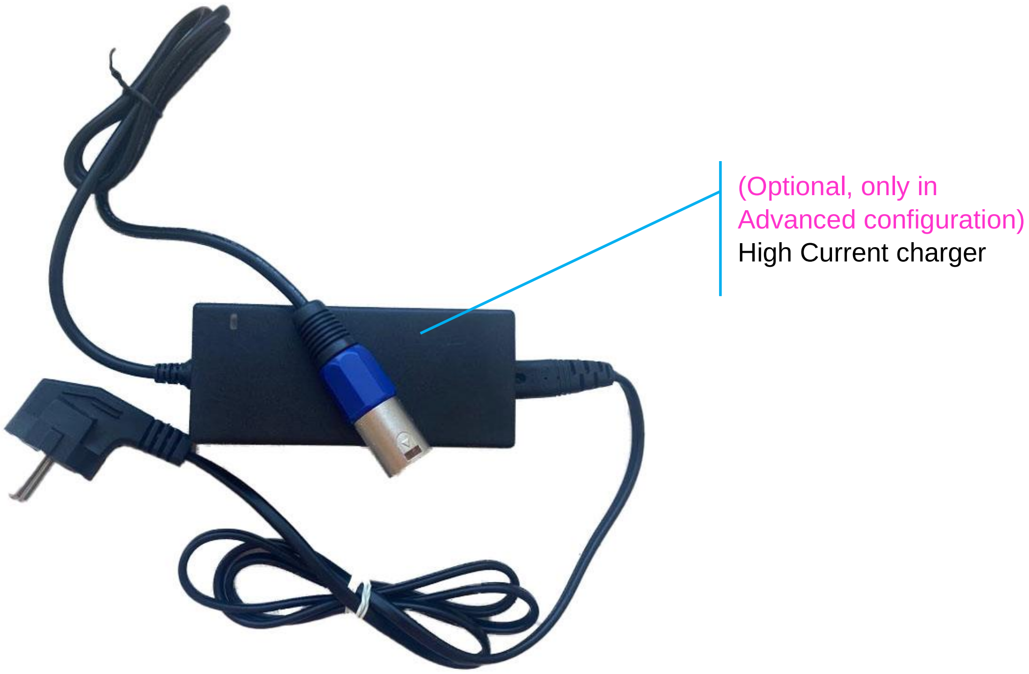
Turn off the robot and connect a charger.

There are two types of charger for Boxie:

- Charger -12V-1A:

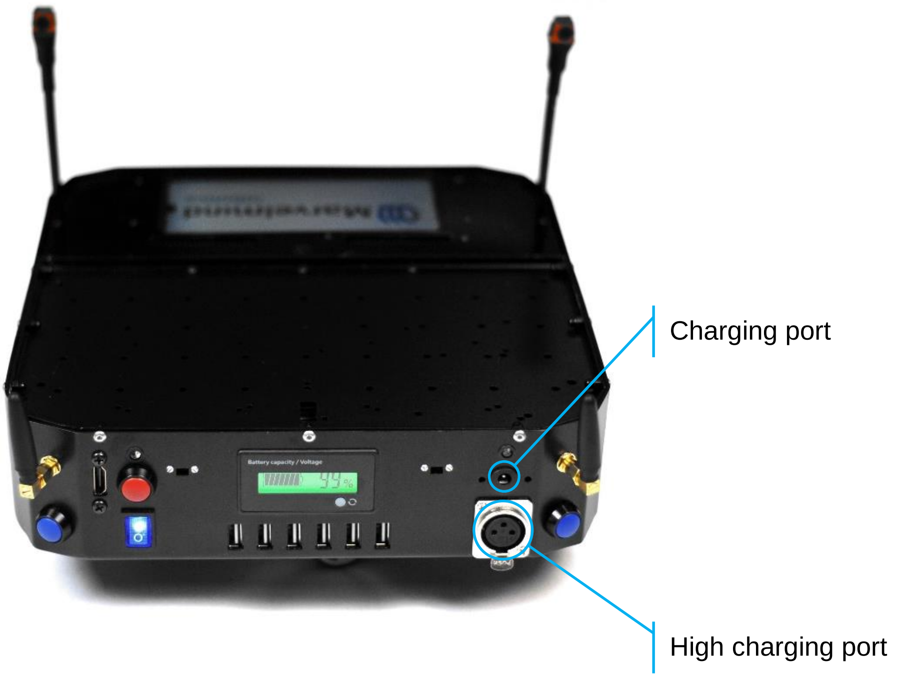
Charging time: 6 hours

- High Current Marvelmind charger (5A):



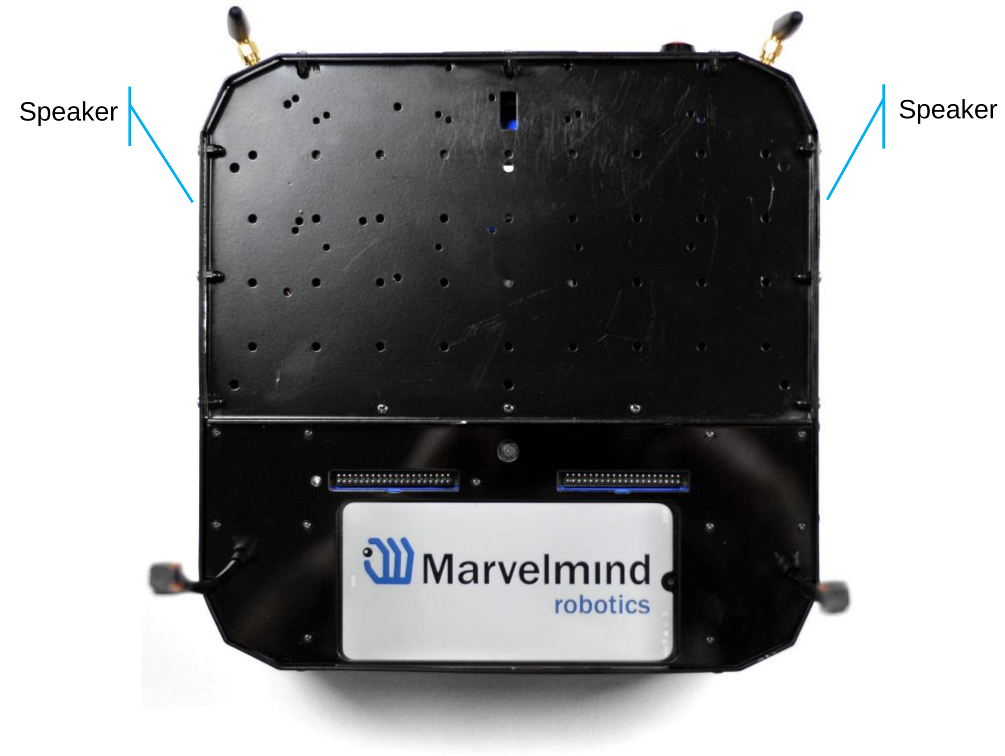
Charging time: 2 hours (optional, only in Advanced configuration)
Operating time at full battery is up to 8 hours (No payload).
Use only Marvelmind supplied chargers

When Boxie is turned off and is charging, display battery and beacons don't charge. Turn on Boxie, to charge a display battery and beacons.



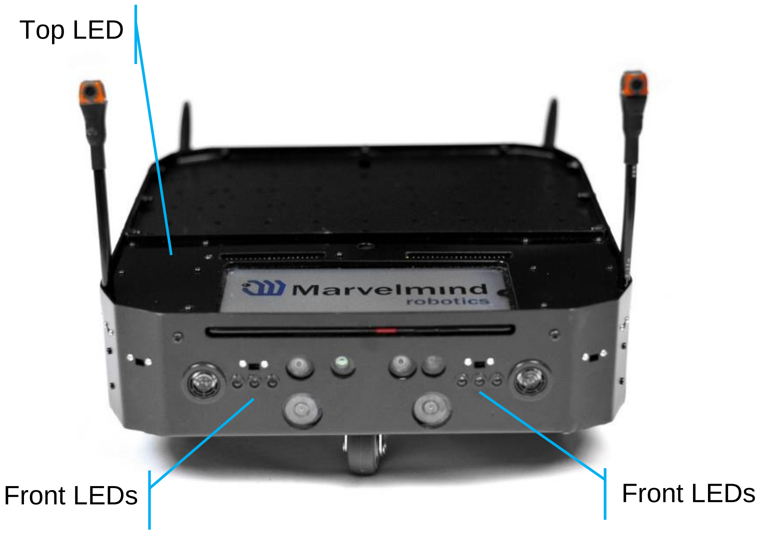
3.9 Speakers

Speakers inform about the current processes of the Robot Boxie.



3.10 LED's

LED (top and 2 x front) for interfacing, debugging and lighting.



Read more about functions of LEDs in Communication chapter.

3.11 Chassis. External interfaces.

External interfaces of Boxie:

- 6 x USB
- 40pins of Pi Zero – standard interface
- 40 pins from our Odometer board:
    - UART
    - SPI
    - I2C
    - USB
    - +12V & 1A and +5V & 1A to power your external devices
    - GND switch
- HDMI (Raspberry Pi connected)
- Stereo sound
- Buzzer
- LED (top and 2 x front) for interfacing, debugging and lighting
- 2 x programmable Functional Buttons and Reset button

The chassis of the Robot Boxie made in a special way.

There are mounting holes for most common boards:

Holes are made for easy installation of additional add-on boards. It is very convenient to place on brass holders, no need to drill holes:

- Raspberry:



- Arduino Uno board:


- Jetson Nano:

4. Software elements and functions

In this chapter described the main software system elements and functions of the Robot Boxie.

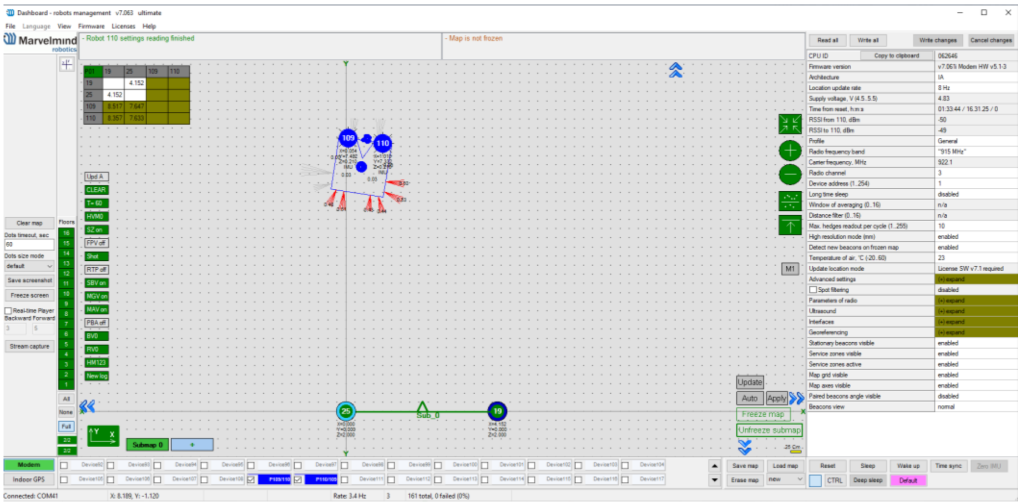
4.1 Control system

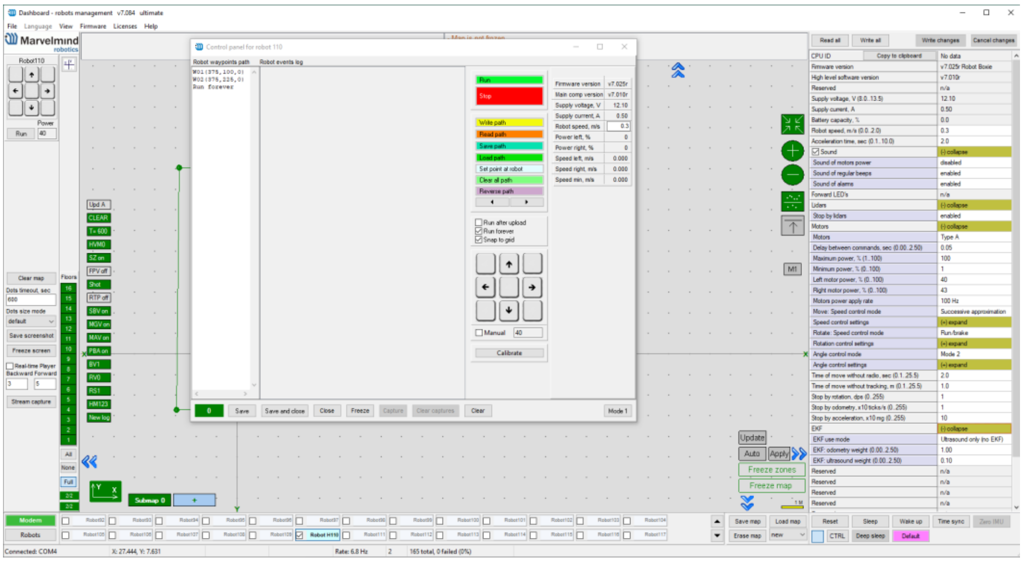
There are two ways to control Marvelmind Boxie system.:

4.1.1 Via dashboard

In this way Boxie controls with Marvelmind Indoor "GPS". When system fully set up, you can control a Boxie via Dashboard. Read more about first setting up a Boxie.

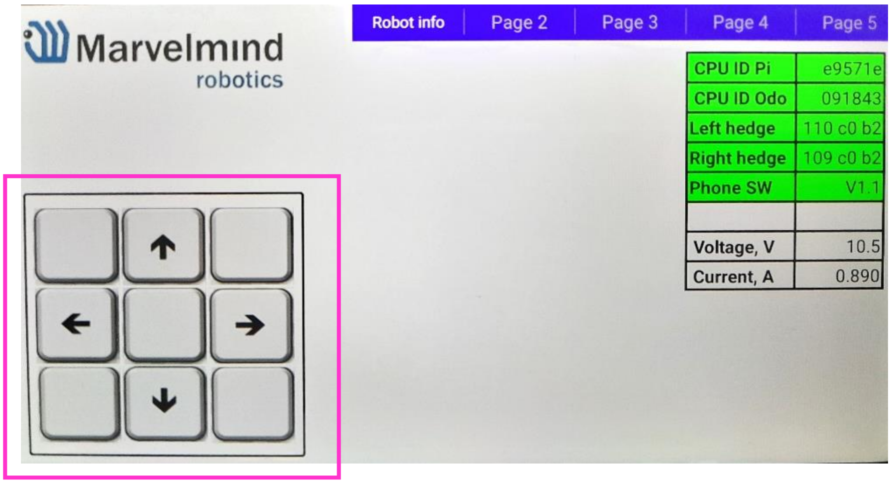
Visual Dashboard view (Check the video: How autonomous robots keep driving so precise?!)





4.1.2 Manual control

In this way, the robot is controlled manually using the Touch Screen Control.

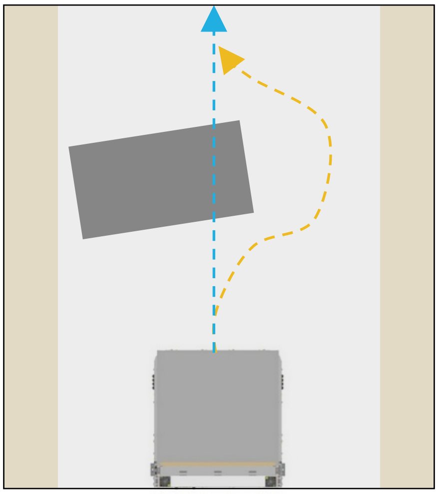


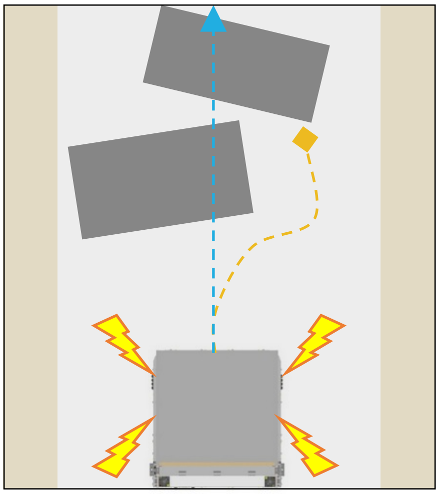
4.2 Obstacle detection and avoidance

Marvelmind team installed multiple [1D LIDAR's](#) into the robot to provide obstacle detection and avoidance up to 4 meters away.

To avoid false alarms, this distance is limited to a meter, which allows the robot to stop and decide to avoid obstacle.

- Adjustable detection distance (0.3-4m)
- Emergency stop - https://youtu.be/efOc-ItVvgg?t=67
- Rebuilding paths and alarming if stuck
- In future SW versions this function will be used as addition to positioning, in difficult cases when positioning via ultrasound is impossible.





4.3 Communication

There are two ways how Boxie can communicate with people:

4.3.1 Sound

This functions are supported by speakers.

- With the help of this sound, the robot warns people about the approach.
- With the voice it informs about the current processes of the Robot Boxie, as written path, flashing, start of a ride and similar actions.

4.3.2 Light

This function supported by LED’s.

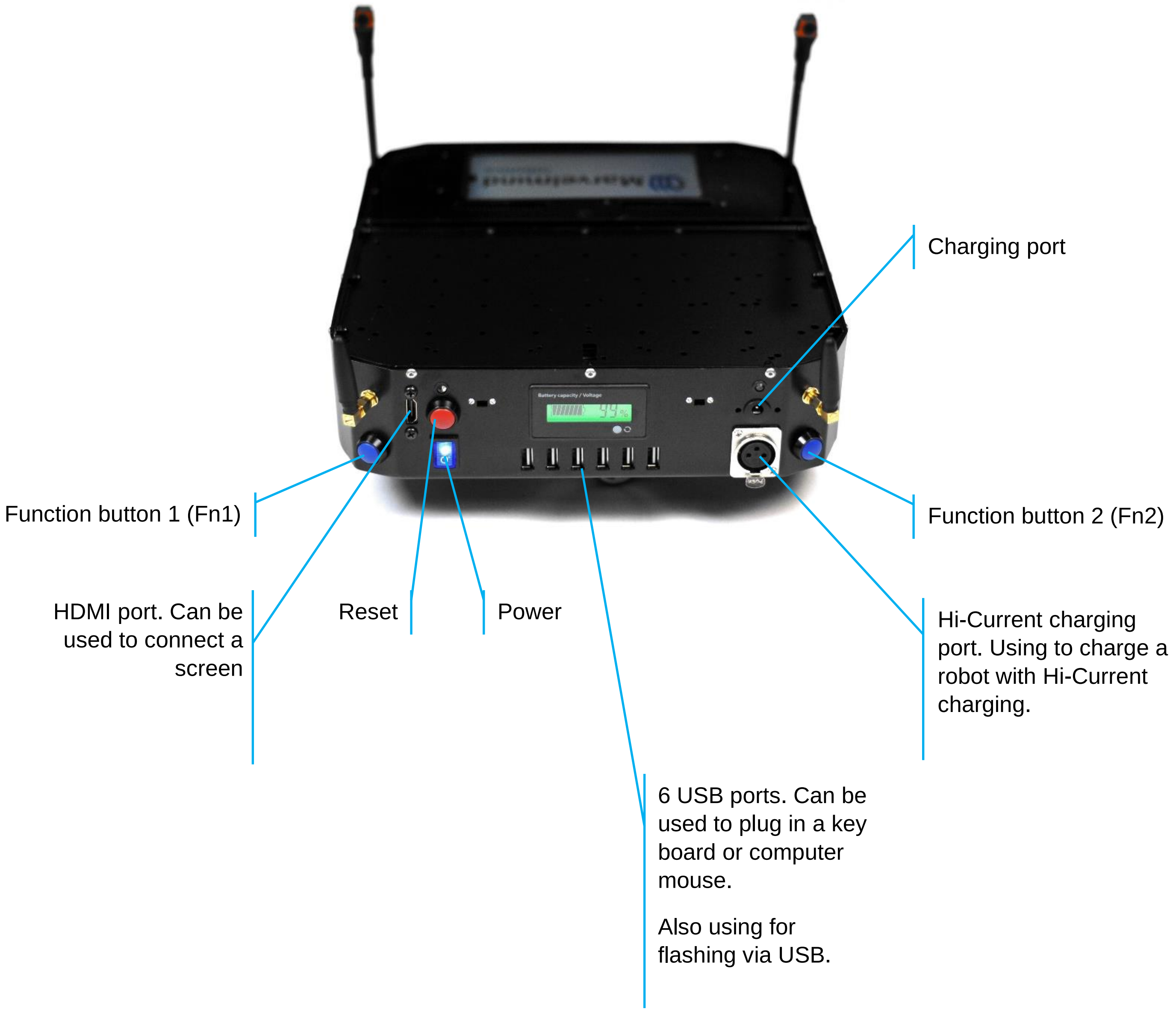
- Helps to indicate Boxie.
- Flashing faster when Boxie flashing via USB.
- Used to illuminate the space when Boxie track via RealSence (Future stage)

5. Setting up the Boxie

This chapter describes interactions with basic robot controls and setting up the system with Marvelmind Boxie.

Notice that Marvelmind Small Robot relays upon Inverse Architecture.

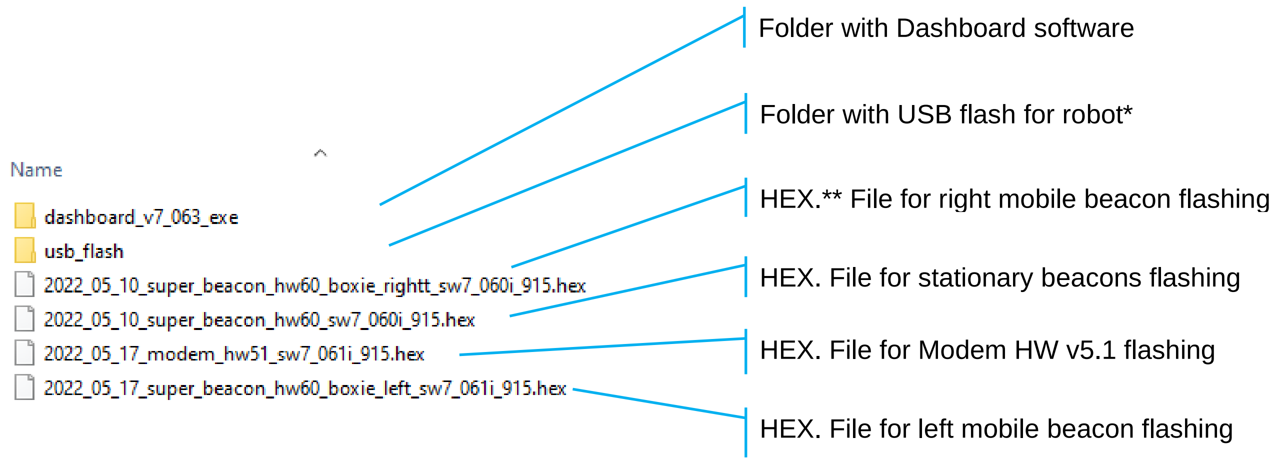
5.1 Back control panel



5.2 Software Pack

When you just received Robot Boxie, update SW on the latest version.

This chapter shows how to use SW Pack for Boxie



*Copy this folder to USB drive, connect it to Robot and press Reset button. After that Boxie will flash by itself.

**Use HEX.files to flash devices via Dashboard. It's possible to flash via USB and radio. Flash mobile beacons via radio (don't try to remove it from robot) and flash stationary beacons via USB or radio, as you prefer.

5.3 One-time flash, for SW version from 7.000

Do this only once, for your Robot Boxie. After this disassembling is not needed, SW flashes via USB.

How to:

- Remove the plastic cover of the robot, to get access to Raspberry:

- Remove the micro SD card from Raspberry board:

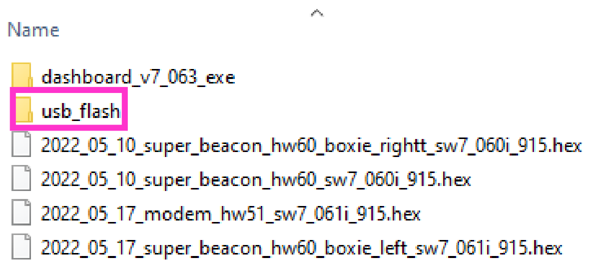
- To reflash the micro SD card you should download the latest Boxie software version from our site (https://marvelmind.com/download/) and write the image file to the micro SD card by appropriate software, for example Win32 Disk Imager.
-
- After the image file written to micro SD, put micro SD back to Raspberry and screw plastic cover back to robot.
- Now, Boxie can be flash via USB.

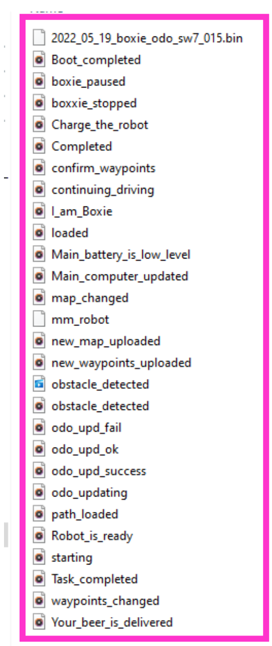
5.4 Flashing via USB

After one-time flash, Robot Boxie flashing via USB. Follow steps below to flash Robot Boxie via USB

1) Download latest SW pack for Boxie from Marvelmind website https://marvelmind.com/download/

2) . Copy all files from usb_flash folder to USB drive





All copied files must be on the upper level of USB drive.

Make sure that there are no any .wav; .mpeg and .bin files on the up level of USB drive that using for flashing. Otherwise, those files may be deleted from the USB drive.

3) Insert USB drive to Robot Boxie and press reset button

4) After reset, Boxie will say, “Main computer updated successfully”. This means that Raspberry flashed.

5) After Raspberry board successfully updated, robot will inform that flashing of Ode. board been started. “Updating of odometry board”. When odometry board updating in progress, robot will beep and blink.

6) In the end of flashing Boxie will inform “Odometry board firmware updated successfully” – it means, that flashing completed. Robot Boxie will be reset by itself.

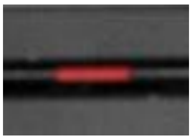
7) Remove USB drive from the Boxie

8) Flashing completed.

5.5 Turning on the Boxie

To turn on the Boxie follow steps below:

- Press the robot display power button and turn on the display:



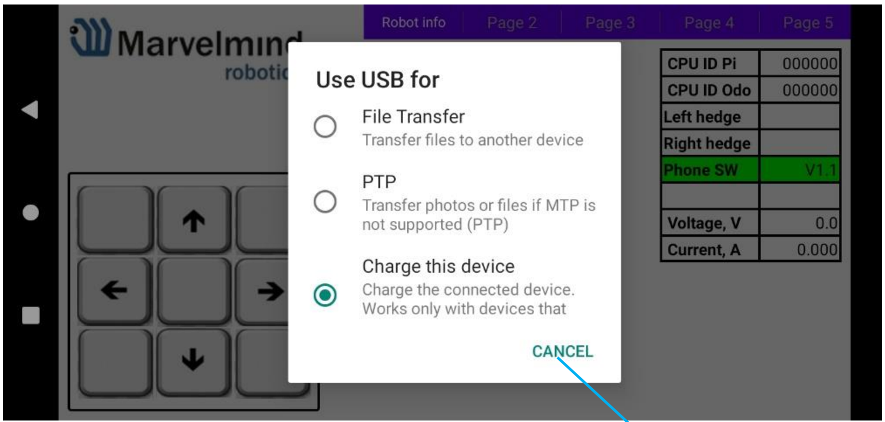
- You will see a home screen of display:

- Leave the display turned on

As long as you turned on the robot display, press power button on a Boxie:

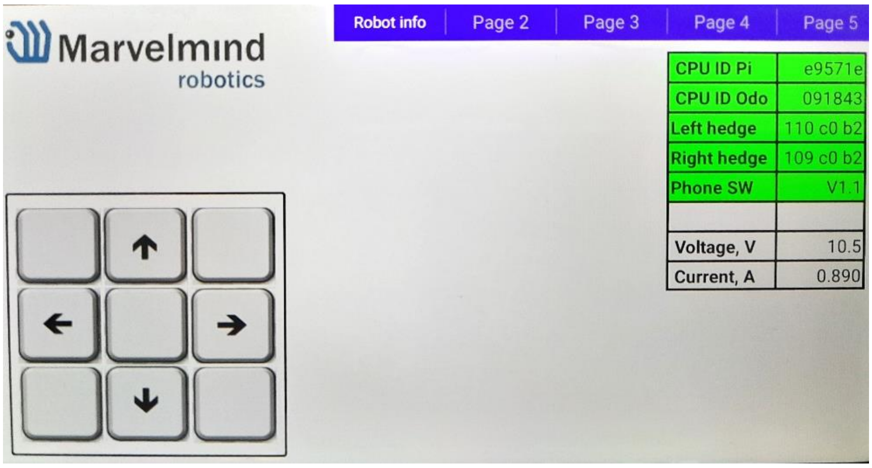
Power switcher

- After turning Boxie on “Marvelmind Boxie” app will turn on automatically
- Press “Cancel” button in menu, when robot is loading. Wait around 10 seconds before press it, if you do it too fast, it won’t boot properly:

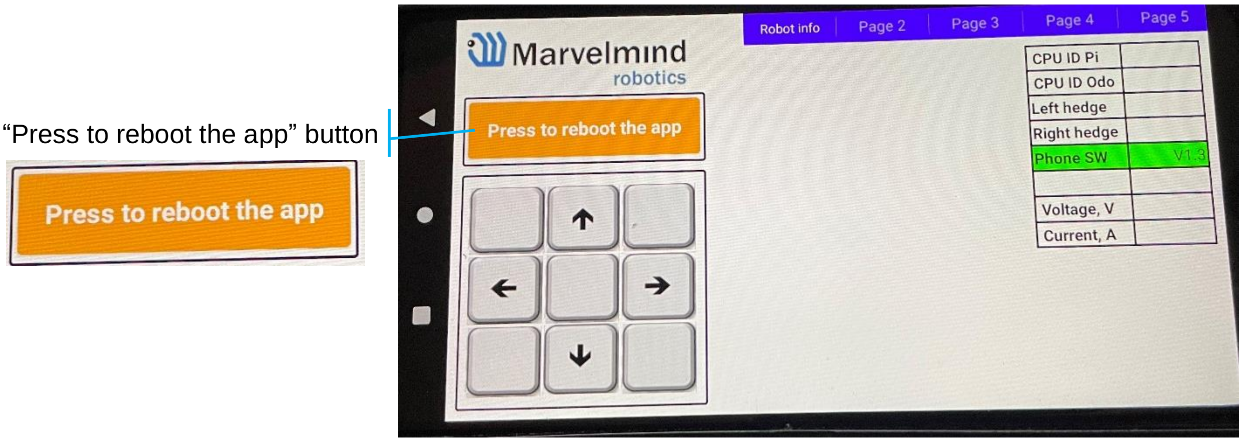


“Cancel” button

- After that app show all information about device. Boxie inform you that "Boot completed". Robot is ready to work:



If app doesn't show the information press "Press to reboot the app" button. After that app will automatically reopen.

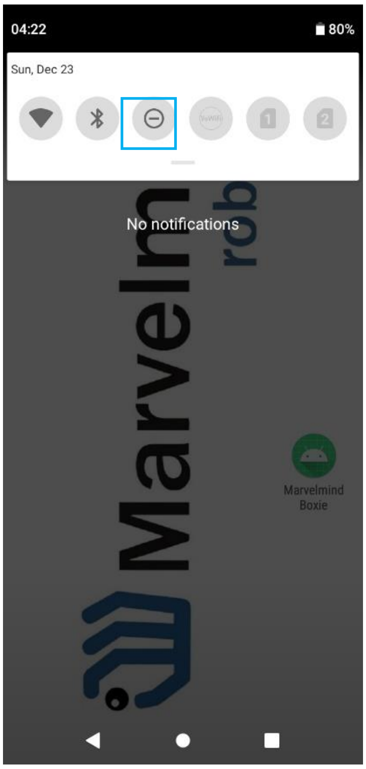


5.5.1 Do not disturb mode

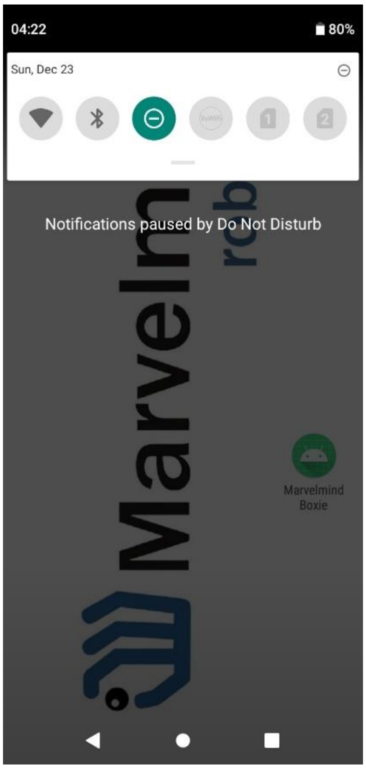
To avoid any notifications, switch on the Do not disturb mode. There are two ways to do that:

First way (easier)

- Swipe screen down from the top side and press this sign:

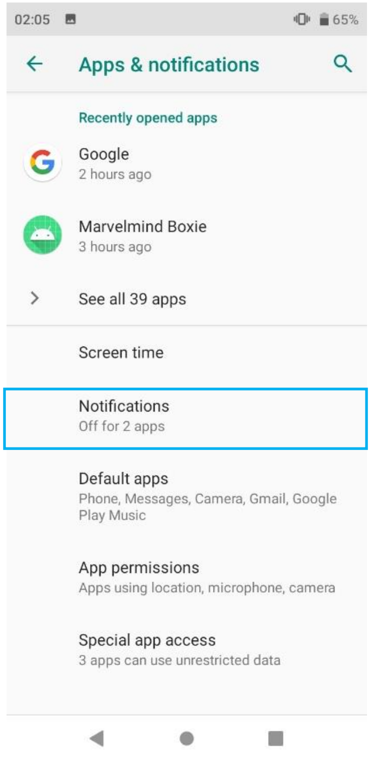


- Sign tern to green. Do Not Disturb mode is activated:

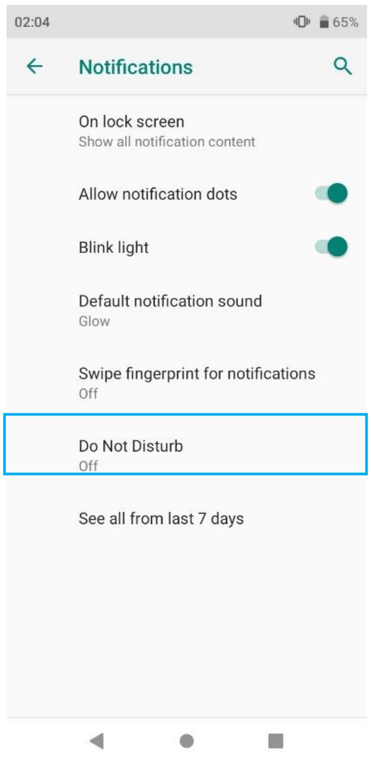


Second way:

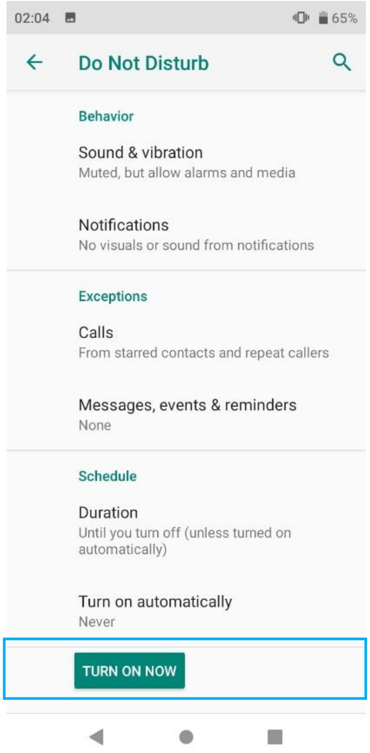
- Go to Settings/Apps & notifications/Notifications:



- Choose Do Not Disturb:



- And press TURN ON NOW button:



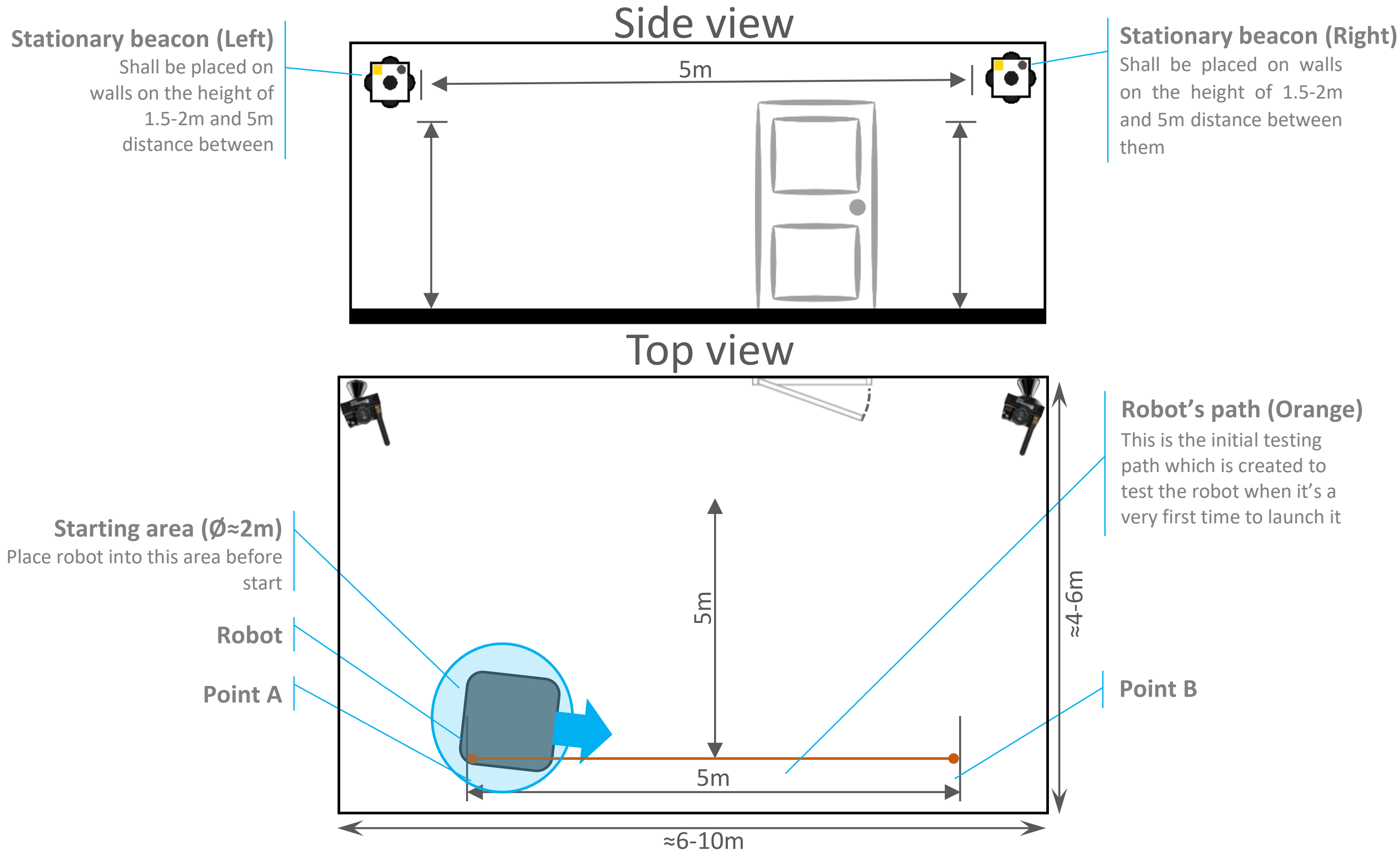
5.6 Test launch

When you flashed the robot, you can start a testing launch process. Test launch is a process of testing for Marvelmind Small Robot. Test launch consists building a simple map and a simple path for robot. If you are experienced enough, you can skip this part and go forward to “Launching robots in custom maps” chapter.

Marvelmind Indoor “GPS” system included only in Advanced configuration. For Basic and Standard sold separately.

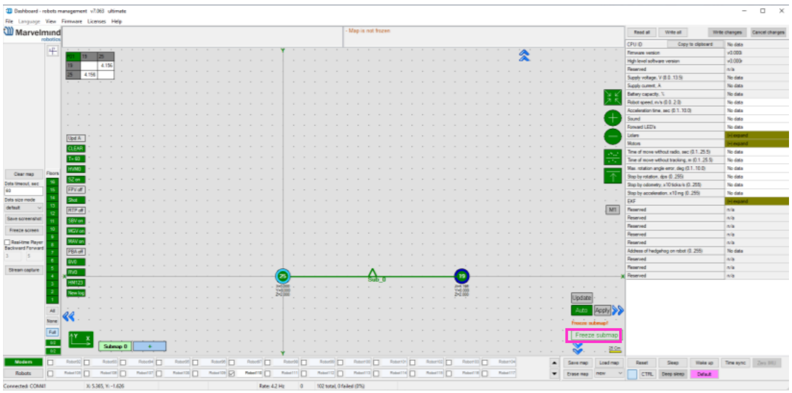
How to:

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



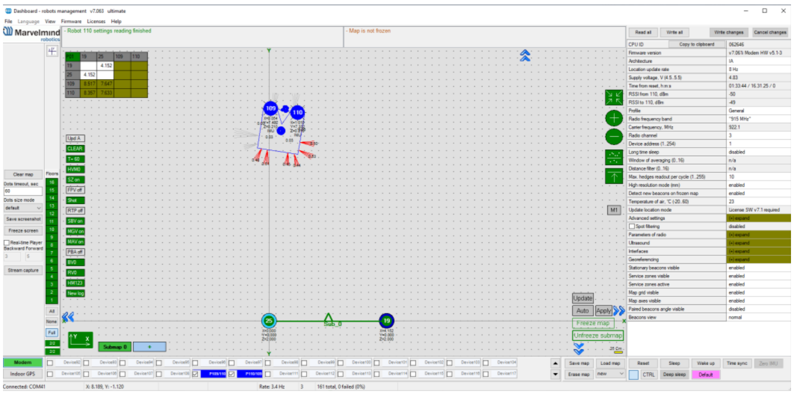
2) Install and launch Marvelmind Dashboard
3) Connect Modem to your PC via USB and update it with the corresponding SW
4) Turn on the robot and wait for 1 minute, until the robot is fully loaded.

5) Check the [Marvelmind Operating Manual](#) and build up a simple 2D map and Freeze Submap:

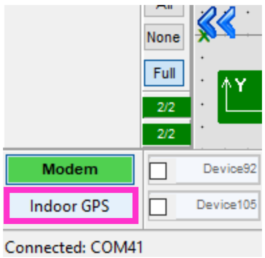


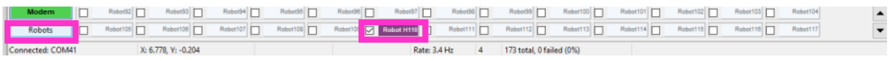
6) Wake up the beacons which are written on the bottom of the Boxie

7) Robot will appear on the map. Wait till Robot setting reading will be finished:

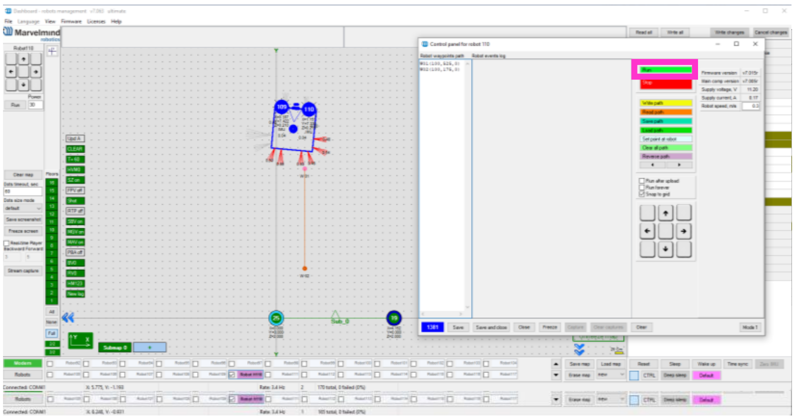


8) Left click to Indoor GPS button and choose Robots option. Find your robot in devices list and Left click on the robot number icon. (Robot named as higher hadge number):

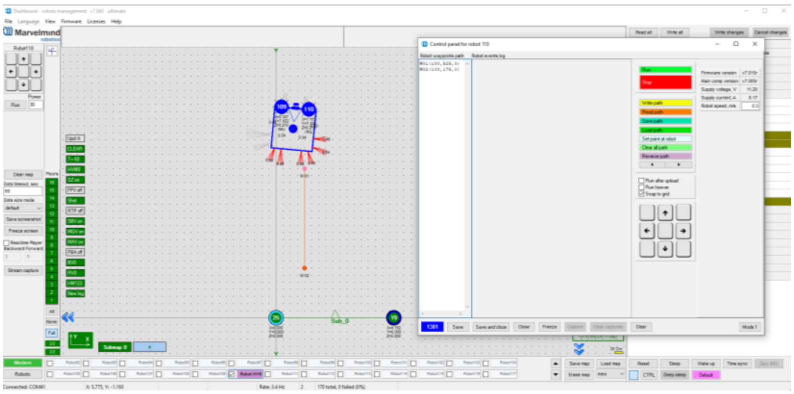




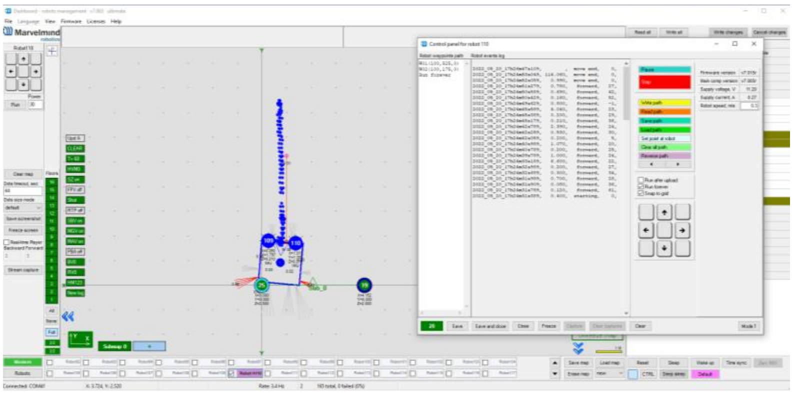
9) Control panel for robot will open:



10) Use **Shift + Left Click** to draw a point of path. And **Shift + Left Click on point** to remove already existed point. Draw the path, as shown in the picture below:



11) Press “Run”. Robot will start a ride:



5.7 Launching Boxie in the custom map

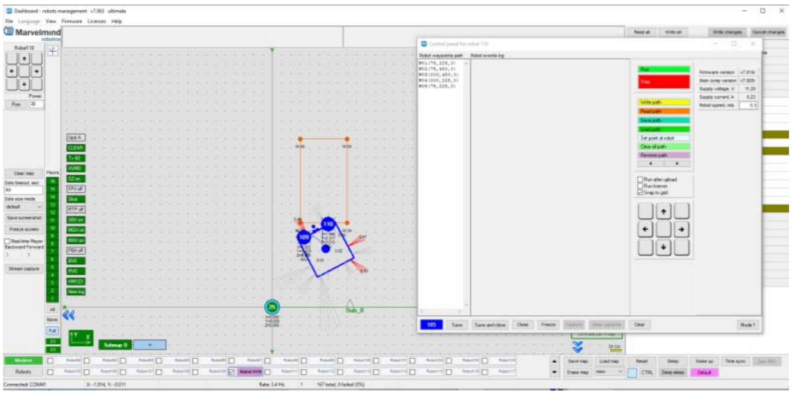
When you made a test launch of the robot and succeed, you can build more complex maps and launch the robot in it.

How to:

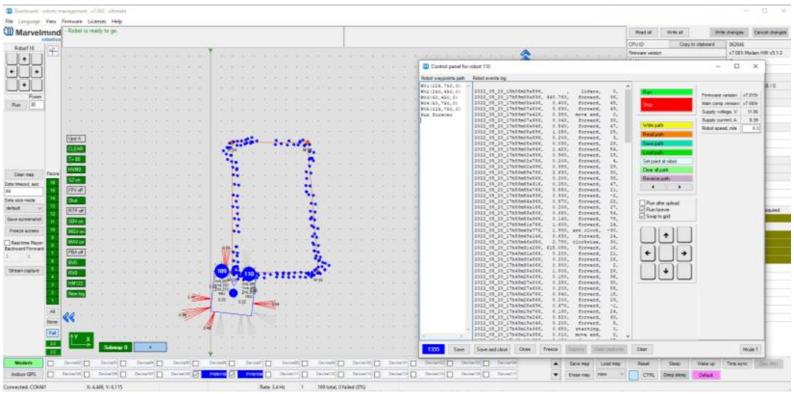
1) Set up the Marvelmind Indoor "GPS" system. It's detailed described in the [Operating Manual]

2) Turn on Boxie and wait for 1 minute

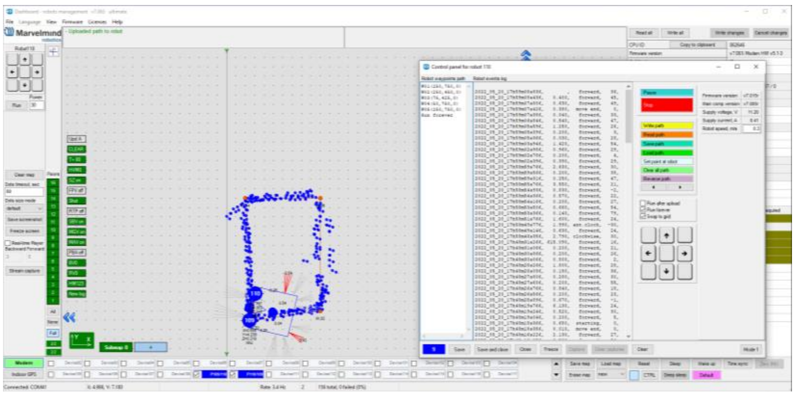
3) Configure paths and points (Use **Shift+Left mouse button click** to create point,



click on point – to remove):



4) Press "Run". Robot will follow the path that you draw:

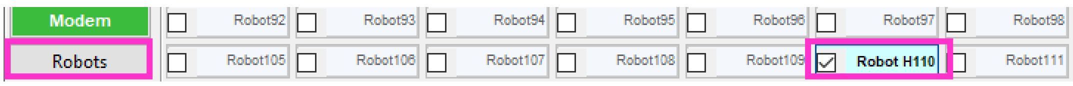


5) If you put a tick on "Run forever". Robot will move till you press stop button in control panel or before obstacle detected:

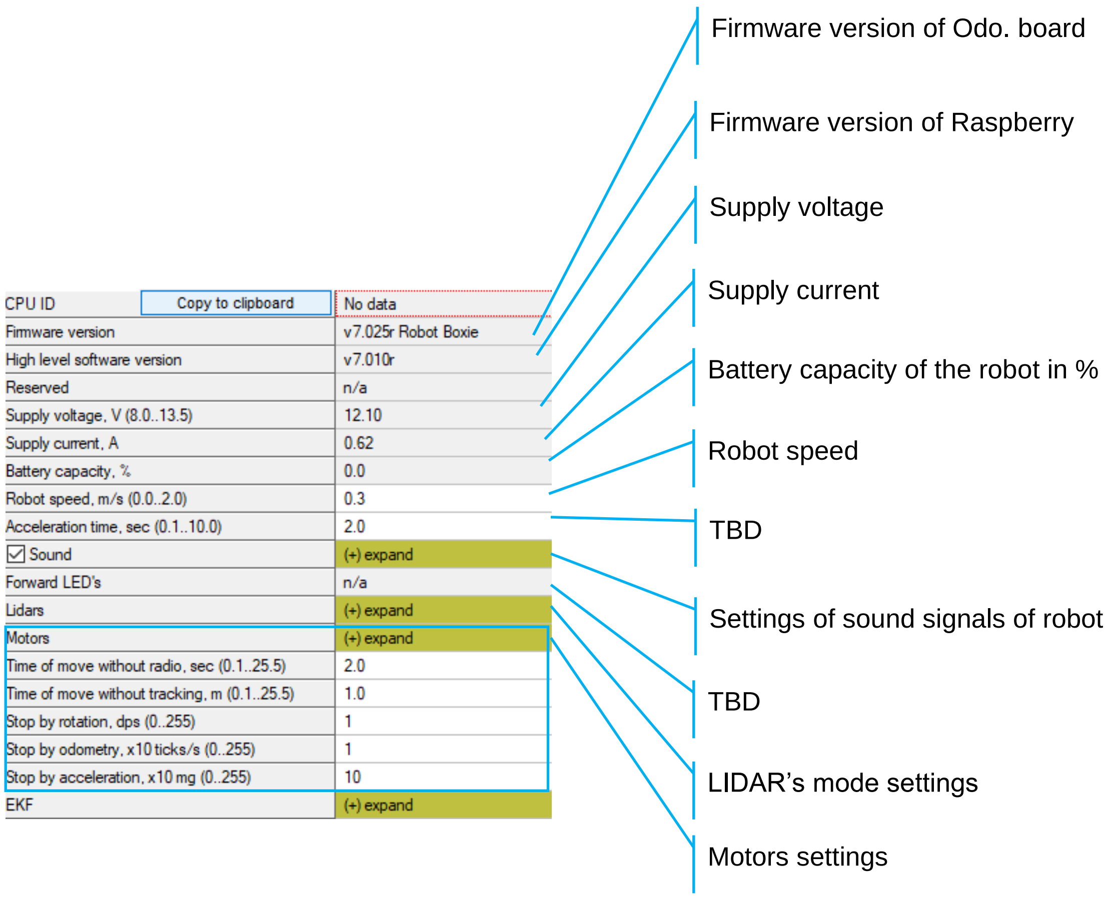
5.8 Dashboard. Robot detailed settings

This bar allows user to adjust device precisely. It contains a lot of parameters for advanced usage.

Choose Robot in robots list, to see Robot detailed settings:



5.8.1 Main settings and information



5.8.2 Motors

Motors	(-) collapse
Motors	Type A
Delay between commands, sec (0.00..2.50)	0.00
Maximum power, % (1..100)	100
Minimum power, % (0..100)	0
Left motor power, % (0..100)	0
Right motor power, % (0..100)	0
Motors power apply rate	100 Hz
Move: Speed control mode	Table power
Speed control settings	(+) expand
Rotate: Speed control mode	Run/brake
Rotation control settings	(+) expand
Angle control mode	Mode 2
Angle control settings	(+) expand
Time of move without radio, sec (0.1..25.5)	0.0
Time of move without tracking, m (0.1..25.5)	0.0
Stop by rotation, dps (0..255)	0
Stop by odometry, x10 ticks/s (0..255)	0
Stop by acceleration, x10 mg (0..255)	0
EKF	(+) expand

Type of the motors installed in a Robot. Do not change.

Maximum power allowed to the robot.

Minimum power allowed to the robot.

Power of left motor of a robot (in manual control mode)

Power of a right motor of a robot (in manual control mode)

Frequency with what the robot recalculates the power of its movement when moving in a path.

Straight-line speed control mode

Settings of straight-line speed control mode (different for each mode)

Speed control mode when turning on the spot.

Settings of Rotate: speed control mode.

Motors	(-) collapse
Motors	Type A
Delay between commands, sec (0.00..2.50)	0.00
Maximum power, % (1..100)	100
Minimum power, % (0..100)	0
Left motor power, % (0..100)	0
Right motor power, % (0..100)	0
Motors power apply rate	100 Hz
Move: Speed control mode	Table power
Speed control settings	(+) expand
Rotate: Speed control mode	Run/brake
Rotation control settings	(+) expand
Angle control mode	Mode 2
Angle control settings	(+) expand
Time of move without radio, sec (0.1..25.5)	0.0
Time of move without tracking, m (0.1..25.5)	0.0
Stop by rotation, dps (0..255)	0
Stop by odometry, x10 ticks/s (0..255)	0
Stop by acceleration, x10 mg (0..255)	0
EKF	(+) expand

Angle control mode

Angle control mode settings

Autonomous movement of a robot, when radio signal is lost.

Autonomous movement of a robot, when ultrasound signal is lost.

TBD

TBD

TBD

Extended Kalman Filter

5.8.3 Speed control settings

- Table power mode

Move: Speed control mode	Table power
Speed control settings	(-) collapse
Move: Start power, % (1..100)	20
Move: Power time quantum, sec (0.01..2.50)	0.21
Move: Power up coefficient (1.01..100.00)	1.50
Move: Speed hystersys coefficient (1.1..10.0)	3.0
Move: Linear start	disabled

Start power
Power time quantum
Power up coefficient
Speed hysteresis
Linear start

- PID

Move: Speed control mode	PID
Speed control settings	(-) collapse
PID for speed - P (0..255)	0
PID for speed - I (0..255)	0
PID for speed - D (0..255)	0

Power time quantum
Power time quantum
Power time quantum

- Successive approximation

Move: Speed control mode	Successive approximation
Speed control settings	(-) collapse
Move: Start power, % (1..100)	20
Move: Power time quantum, sec (0.01..2.50)	0.21
Move: Power up coefficient (1.01..100.00)	1.50
Move: Power down coefficient (0.01..0.99)	0.80
Move: Speed hystersys coefficient (1.1..10.0)	3.0
Move: Linear start	disabled

Start power
Power time quantum
Power up coefficient
Power down coefficient
Speed hysteresis
Linear start

- Constant power

Move: Speed control mode	Constant power
Speed control settings	(-) collapse
Move: Start power, % (1..100)	20

Start power

5.8.4 Rotate: Speed control mode

- Run/brake

Rotation control settings	(-) collapse
Rotate: Start power, % (1..100)	35
Rotate: n1 (1..20)	2
Rotate: Power P2, % (1..200)	25
Rotate: Power time quantum, sec (0.01..2.50)	0.10
Rotate: Angle delta4, deg (1..90)	22
Auto adjust brake acceleration	disabled

Start power

Rotate coefficient

Power P2

Power time quantum

Angle delta

Direction control mode (to avoid fast direction change)

- Rule based mode 1

Rotate: Speed control mode	Rule based mode 1
Rotation control settings	(-) collapse
Auto adjust brake acceleration	disabled

Direction control mode (to avoid fast direction change)

- Successive approximation

Rotate: Speed control mode	Successive approximation
Rotation control settings	(-) collapse
Rotation speed, dps (1..100)	50
Rotate: Start power, % (1..100)	35
Rotate: n1 (1..20)	2
Rotate: Power P2, % (1..200)	25
Rotate: n2 (1..200)	2
Rotate: K2 (0.01..2.50)	0.70
Rotate: Power time quantum, sec (0.01..2.50)	0.10
Rotate: n3 (1..200)	2
Rotate: K3 (0.01..1.00)	0.70
Rotate: Angle delta3, deg (1..200)	15
Rotate: Angle delta4, deg (1..90)	22
Auto adjust brake acceleration	disabled

Rotation speed

Start power

Rotate: n1

Power P2

Rotate: n2

Rotate: K2

Power time quantum

Rotate: n3

Rotate: K3

Angle delta3

Angle delta4

Direction control mode (to avoid fast direction change)

- Constant power

Rotate: Speed control mode	Constant power
Rotation control settings	(-) collapse
Rotate: Start power, % (1..100)	35
Auto adjust brake acceleration	disabled

Start power

Direction control mode (to avoid fast direction change)

- Table power

Rotate: Speed control mode	Table power
Rotation control settings	(-) collapse
Rotation speed, dps (1..100)	50
Rotate: Start power, % (1..100)	35
Rotate: Power up coefficient (0.01..2.50)	0.70
Rotate: Power down coefficient (0.01..2.50)	0.10
Rotate: Speed hystersys coefficient (0.01..1.00)	0.70
Rotate: Angle delta3, deg (1..200)	15
Rotate: Angle delta4, deg (1..90)	22
Auto adjust brake acceleration	disabled

Rotation speed

Start power

Power up coefficient

Power down coefficient

Speed hysteresis coefficient

Angle delta3

Angle delta4

Direction control mode (to avoid fast direction change)

5.8.5 Angel control mode

- Mode 2

Angle control mode	Mode 2
Angle control settings	(-) collapse
Time of angle correction, sec (0.01..2.50)	0.20
Power of angle correction, % (1..100)	4
Min. angle error, deg (1..200)	7
Road width, meters (0.00..2.50)	0.35
High angle error, deg (1..200)	15
High angle correction time, sec (0.00..2.50)	0.10
High angle correction power, % (1..100)	7

Time of angle correction
Power of angle correction
Min. angle error
Road width
High angle error
High angle correction time
High angle correction power

- PID

Angle control mode	PID
Angle control settings	(-) collapse
PID for angle - P (0..255)	0
PID for angle - I (0..255)	0
PID for angle - D (0..255)	0
Road width, meters (0.00..2.50)	0.35
High angle error, deg (1..200)	15
PID scale coefficient (1..100)	7
Lock regulation with zero speed	enabled

PID for angle - P
PID for angle - I
PID for angle - D
Road width
High angle error
PID scale coefficient
Lock regulation with zero speed

5.8.6 EKF

- Odometry + Ultrasound

EKF	(-) collapse
EKF use mode	Odometry+Ultrasound
EKF: odometry weight (0.00..2.50)	0.00
EKF: ultrasound weight (0.00..2.50)	0.00

EFK use mode

Odometry weight (available only for Odometry + Ultrasound mode)

Ultrasound weight (available only for Odometry + Ultrasound mode)

- Odometry only (no EKF)

EKF	(-) collapse
EKF use mode	Odometry only (no EKF)
EKF: odometry weight (0.00..2.50)	0.00
EKF: ultrasound weight (0.00..2.50)	0.00

EFK use mode

Odometry weight (available only for Odometry + Ultrasound mode)

Ultrasound weight (available only for Odometry + Ultrasound mode)

- Ultrasound only (no EKF)

EKF	(-) collapse
EKF use mode	Ultrasound only (no EKF)
EKF: odometry weight (0.00..2.50)	0.00
EKF: ultrasound weight (0.00..2.50)	0.00

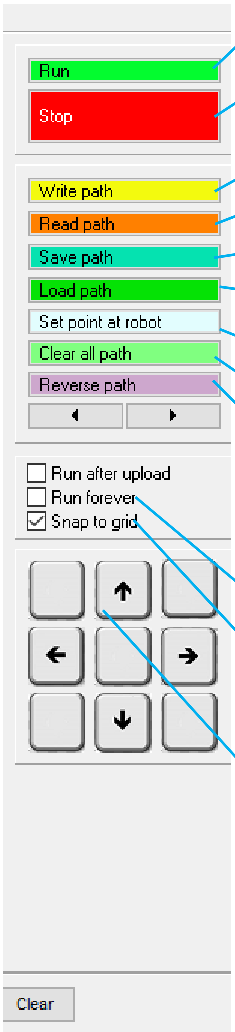
EFK use mode

Odometry weight (available only for Odometry + Ultrasound mode)

Ultrasound weight (available only for Odometry + Ultrasound mode)

5.9 Control Panel for robot

Control Panel opens when you click on the robot on the map or on the robot sign in devices panel.



Run/Pause button. Using to let the robot follow drawn path. Path writes automatically, when you press this button

Stop button. Using to stop robot.

Read path button. Using to wright drawn path

Read path button. Using to read already drawn path

Save path button. Using to save a path in a folder

Load path button. Using to load a path from a folder

Set point at robot button. Using to put a path point In the place where robot located.

Clear all path button. Using to remove all path points from map.

Reverse path. Using to reverse path according to Submap.

Run forever tic. Using to make robot all the time repeat path, till you stop it.

Snap to grid tic. Using to snap path to a grid

Control panel. Using for manual robot control

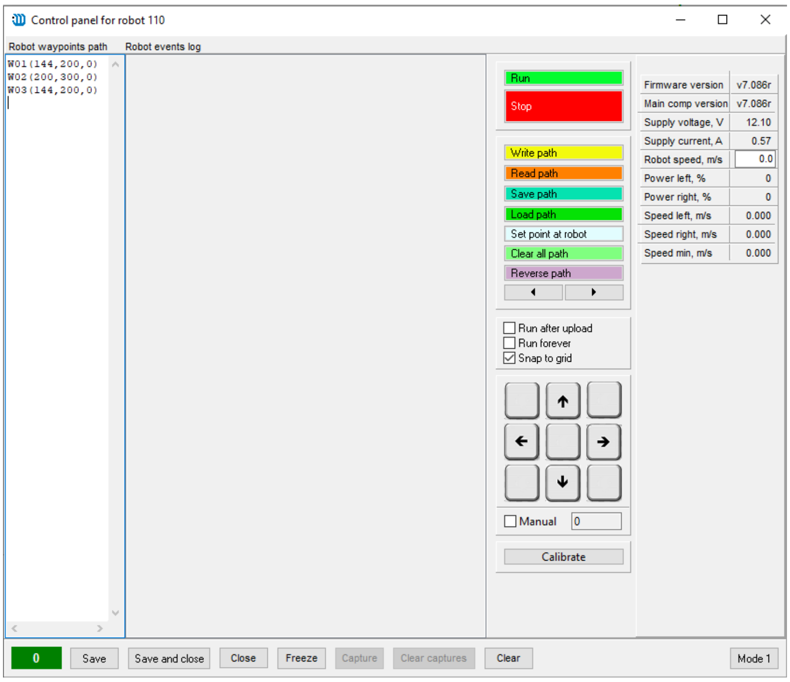
6. Advanced features

6.1 High-level robot control

Below is a list of commands for manually compiling the path of the robot. From these, you can compose the robot's behavior such as the direction of movement and interaction with other devices. If you need more advanced commands to configure the robot, contact us at info@marvelmind.com and we will try to include these commands in the next release of SW Pack for Boxie.

The commands are executed one after the other from top to bottom.

After pressing the Run button, the commands are sent to the robot, after which it says 'Path loaded'. It then says 'Starting' and starts executing the first (upper) command



In the process, you can pause the execution with the Pause button (after that, you can continue from where you stopped with the Continue button),

The Stop button stops without the possibility of continuing, you can only start over

Commands:

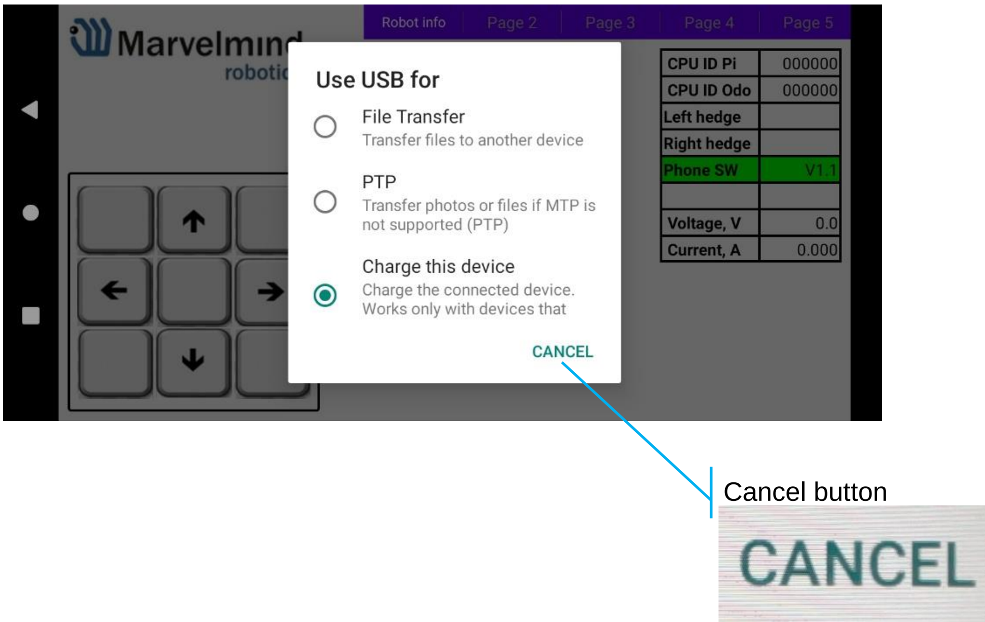
Command name	General format	Command example	Comment
Movement to a given point (waypoint)	Wnn(X,Y,Z)	**W01(1000,2000, 0)** Here: 01 - point number 1000 - X coordinate of the point in cm, i.e. 10.00 m 2000 - Y coordinate of the point in cm, i.e. 20.00 m 0 - Z coordinate of the point in cm, i.e. 0.0 m	1. For the Boxie robot, Z coordinate can be anything, for example 0. Reserved for robots that can move in 3D 2. It is not necessary to enter commands to move to a point manually - you can click shift + click on the desired point on the map
Rotate clockwise by a specified angle	Clockwise(A)	**Clockwise(90)** Here: 90 - the angle to turn, degrees	
Rotate counterclockwise by a specified angle	Counterclockwise(A)	**Counterclockwise(90)** Here: 90 - the angle to turn, degrees	
Moving forward a specified distance	Forward(D)	**Forward(100)** Here: 100 - movement distance in cm	The word 'Forward' can be shortened to 'F': F(100)
Moving backward a specified distance	Backward(D)	**Backward(100)** Here: 100 - movement distance in cm	The word 'Backward' can be shortened to 'B': B(100)
Pause in motion	P(T,B)	**P(10.5, 1)** Here: 10.5 - pause time, sec 1 - button number (behind Boxie) - 1 or 2	The pause ends either after the time has elapsed, or by pressing the specified button Instead of time, you can write 'inf', then there will be no time limit Instead of the button number, you can write 'any', then the pause will end when you press any button
Repeating a sequence of commands in an infinite loop	Run forever	**Run forever**	If this command is present at the end of a sequence of commands, the sequence is repeated in an endless loop You can insert/delete this command with the 'Run forever' checkbox in the control window.

7. Trouble shootings

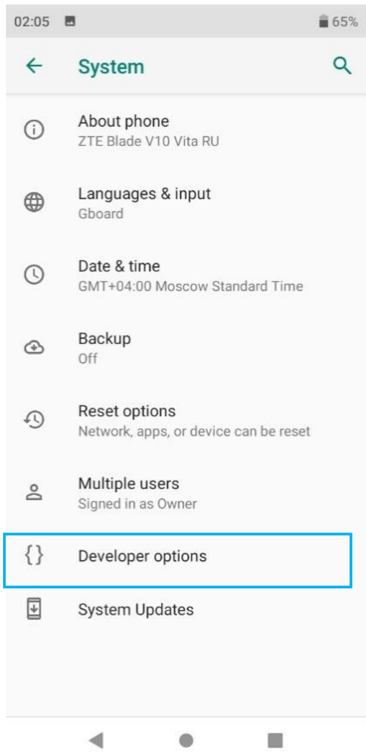
7.1 Display doesn't show robot data

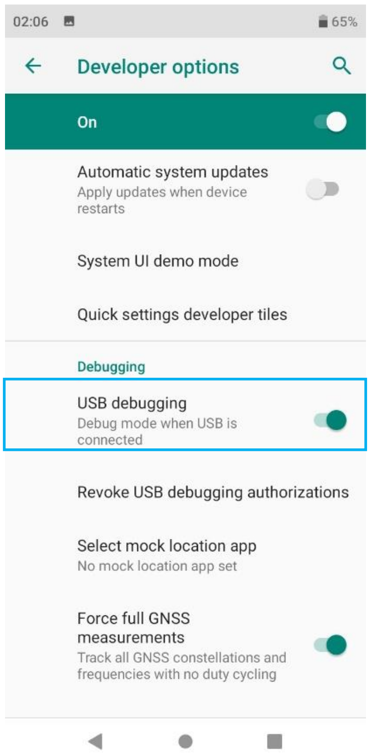
If display doesn't show robot data, follow this steps:

1) Press cancel button in menu, when robot is loading. Wait around 10 seconds before press it, if you do it very fast, it won't boot properly.

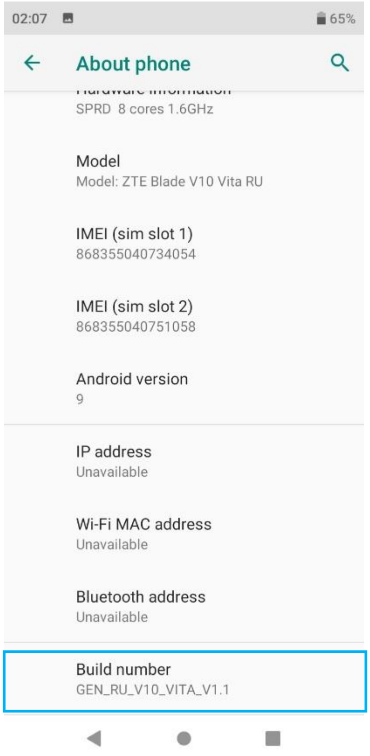


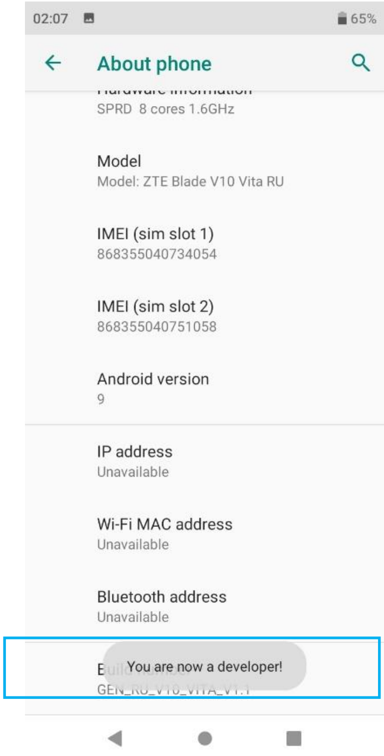
2) Go to Settings/System/Advanced/Developer options, make sure USB debugging is enabled.





3) If Developer options doesn't appear in menu on the previous step, go to System/About phone and click 7-8 to Build number, till message "You are developer" appear.





7.2 What to do if display doesn't work

If the Robot Display doesn't react on a swipe:

1) Try to hold area around display, with one hand and swipe again. After that display should work properly.
2) Wipe the display and try to swipe again

8. Contacts

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