Hackerboard

Introduction

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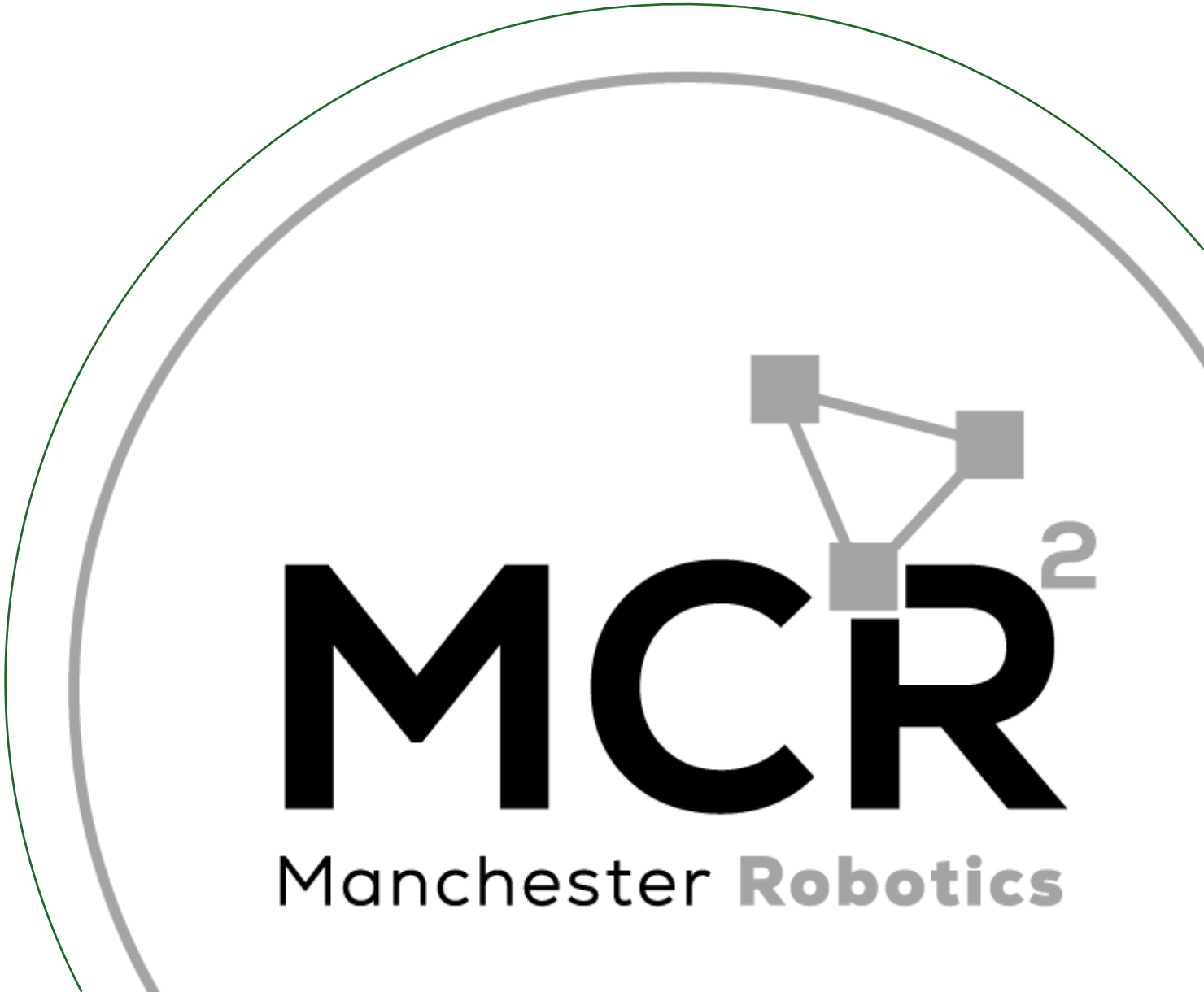
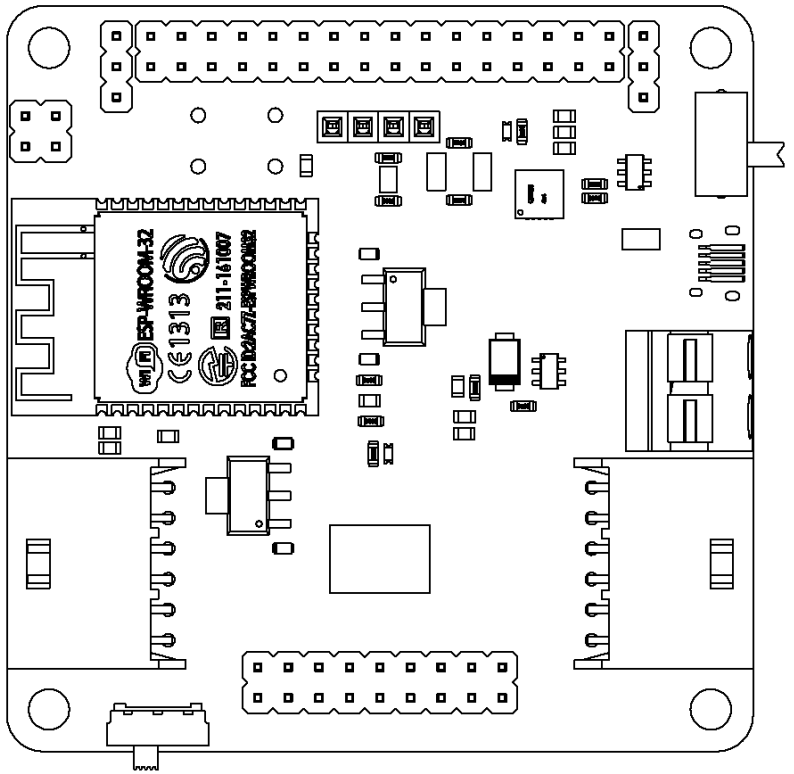


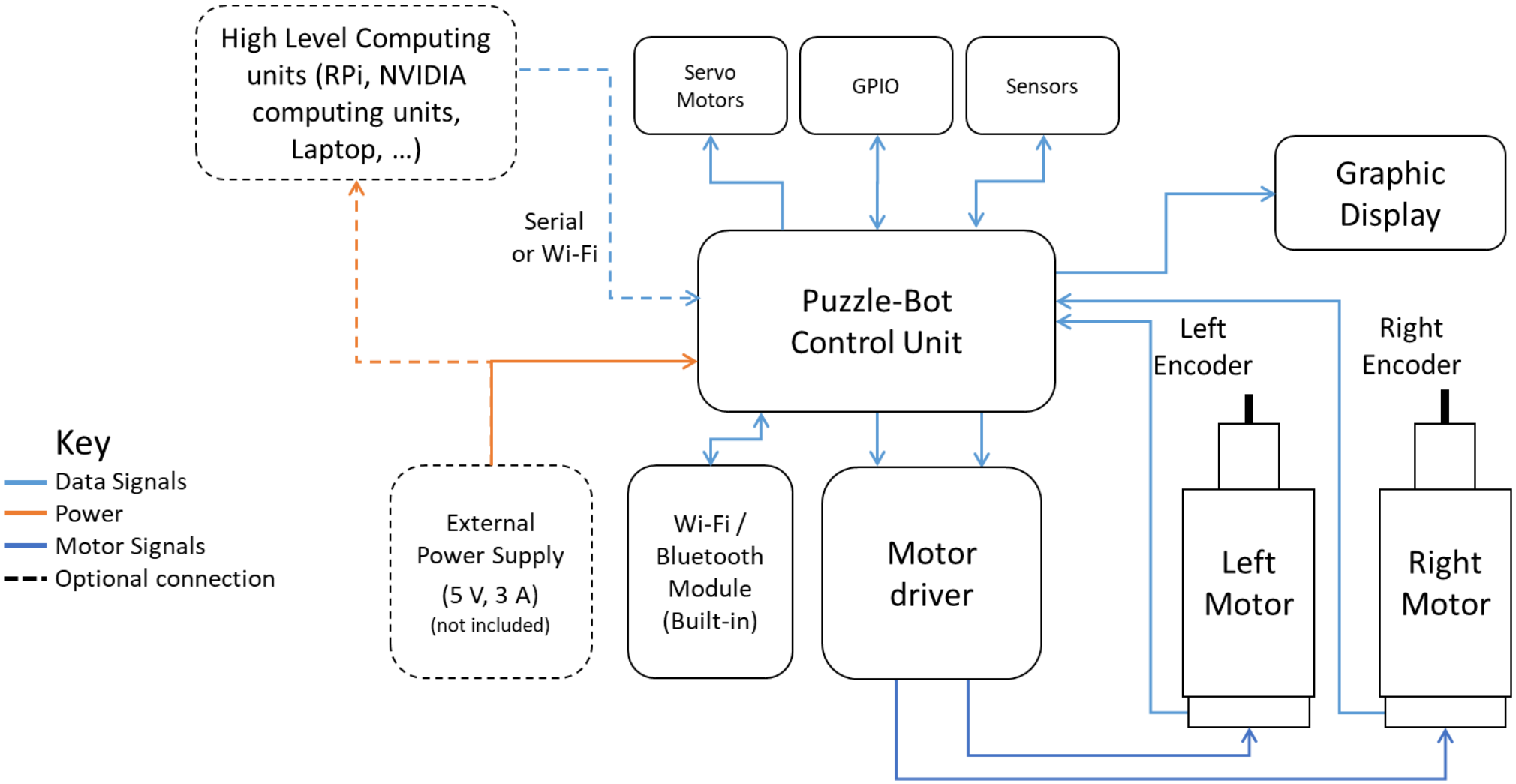
The Hacker Board

General characteristics

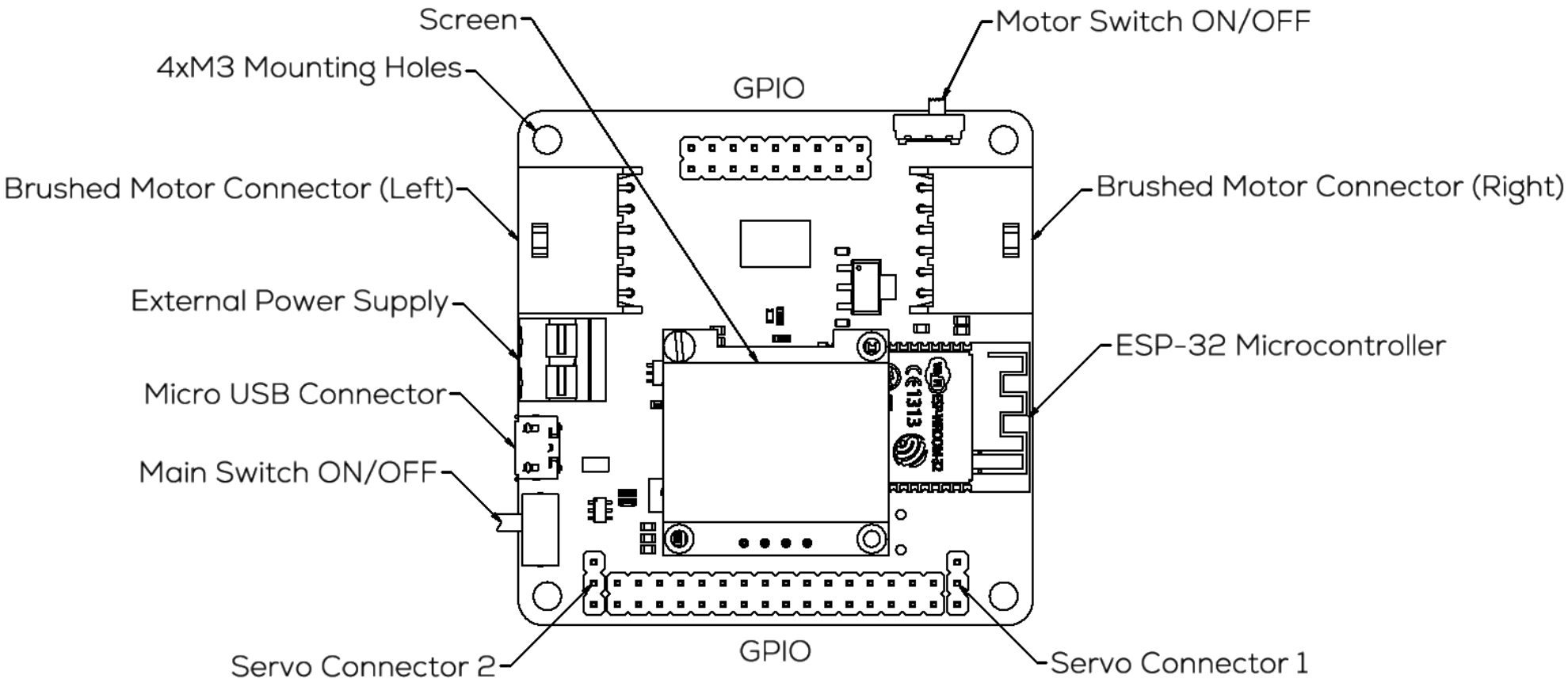
- ESP32-based Microcontroller
  - Xtensa dual-core 32-bit LX6 microprocessor
  - 520 KB of SRAM
  - Wi-Fi & Bluetooth
- DC-DC Converter
- Motor Driver
- 0.96” I2C LCD Display



System Architecture



The Hacker Board



For additional details, please refer to the pinout diagram.

Hackerboard

Control Modes

The Hackerboard has two different control modes depending on the user's requirements.

- The two programming configurations:
  - Standalone Configuration
  - External-Control Configuration

Control Mode: Standalone Configuration (Information purpose only)

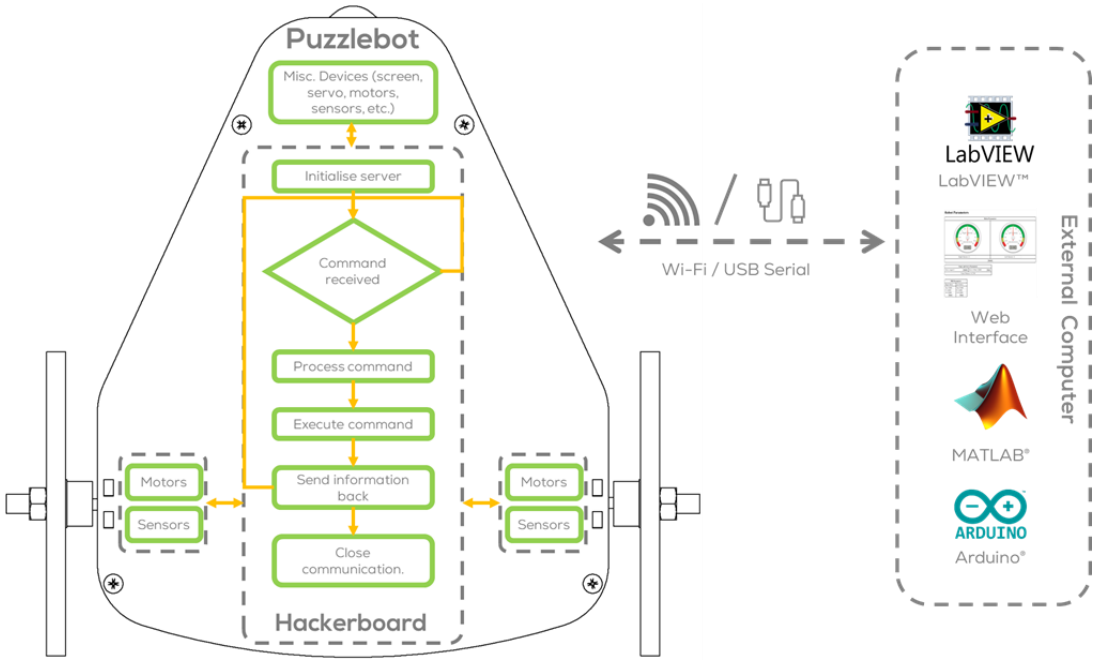
- The user directly programs the Hacker Board, using the Arduino IDE.
- Libraries for control and communication with computing units, sensors, and actuators are provided by MCR2.
- 3rd Party peripherals can be attached.
- This configuration will not be used for this Puzzlebot version.
- For additional examples and a more in-depth understanding, please consult the "Puzzlebot Hacker Edition" manual.

Hackerboard

Control Mode: External Control Configuration

The robot is controlled from an external computer via Wi-Fi or Serial Communication.

- The internal firmware and libraries for communicating with the robot's sensors and actuators are provided by MCR2.
- Basic web interface for configuring and testing provided.
- MCR2 provides MATLAB , ROS and LabVIEW libraries for communicating with the robot.
- This configuration will be used for this Puzzlebot version.
- For additional examples and a more in-depth understanding, on how to use MATLAB or LabVIEW communications and simulators, contact us.



Hackerboard

Flashing the Hackerboard

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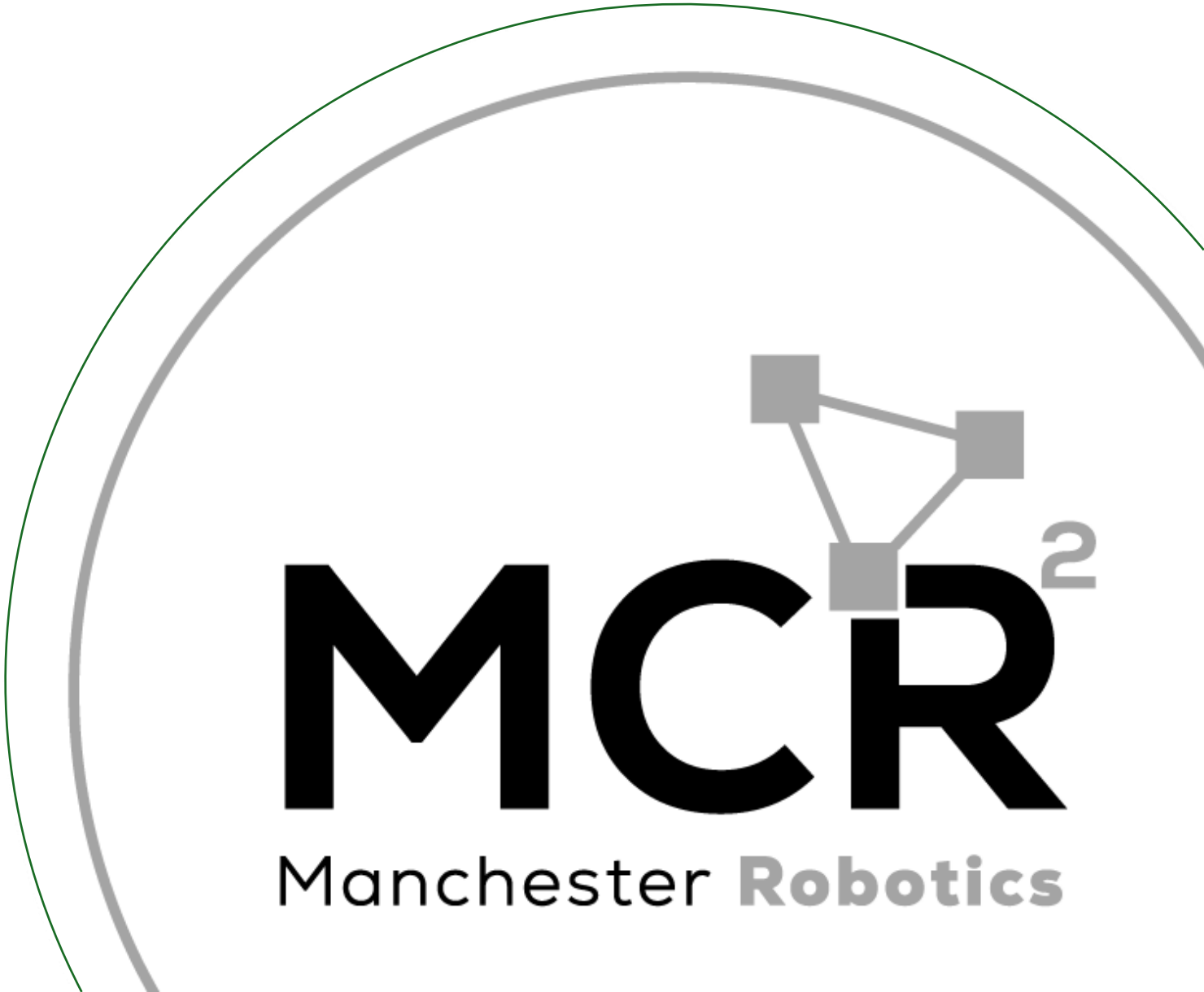
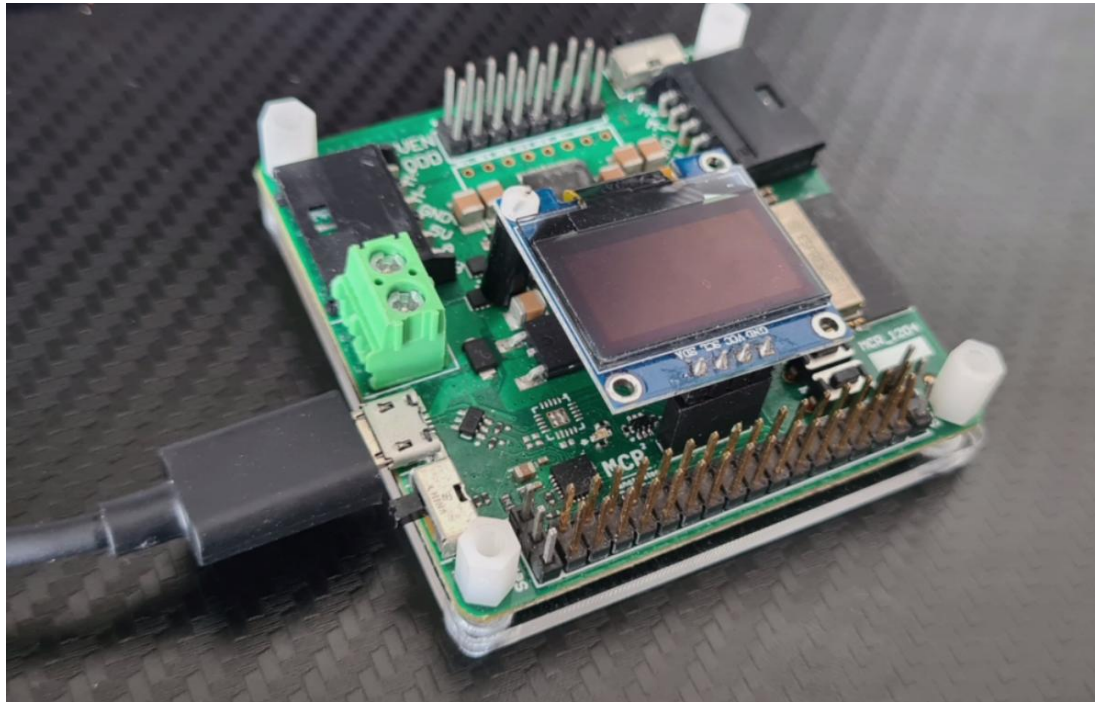


Hackerboard: Flashing the Binaries

Flashing Hackerboard

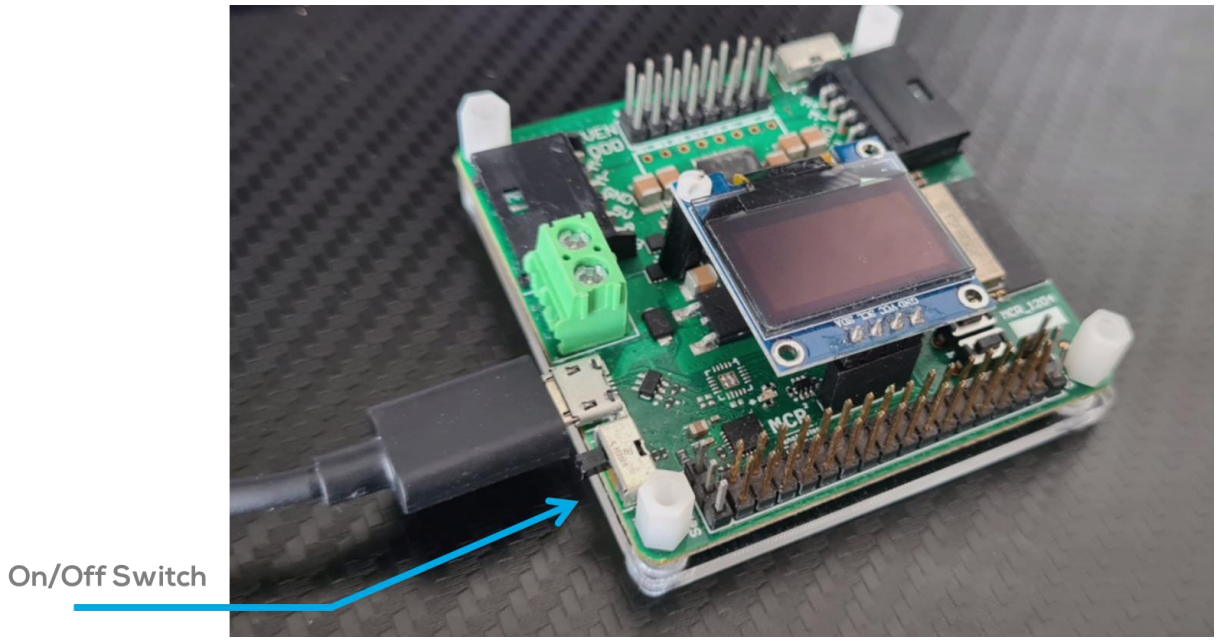
- MCR2 provides the firmware binaries for the External Computing Unit Control Mode.
- This section will guide the user on how to flash such binaries.
- All the robots come preprogrammed with such binaries unless the user modifies the program (On Board Configuration).
- The original binaries can be flashed anytime by following the steps in this section.



Hackerboard: Flashing the Binaries.

Steps

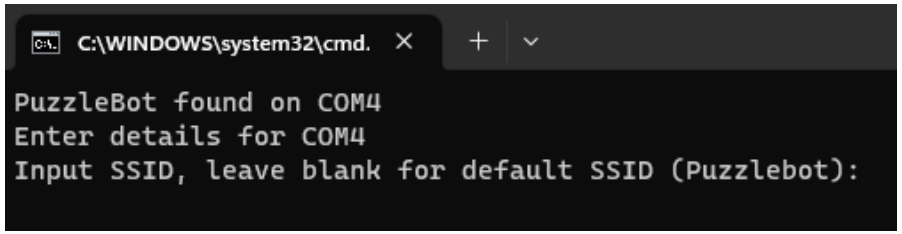
1. Attach the micro-USB cable to the Puzzle-Bot Control Module. *Note the image is just for explanation purposes, detachment of the Puzzle-Bot Control module from the robot is not necessary.*
2. Make sure the Hackerboard power switch is turned on.
3. Connect the USB to any free USB port in the computer
4. Download the firmware from the MCR2 GitHub and extract it.
5. Select the OS of the computer that will perform the flash.
6. Run the file *"FirmwareFlash"*
    - For Linux and MacOS users, it may be necessary to set execution permissions in properties.

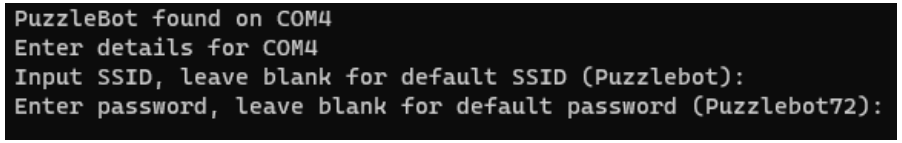


Hackerboard: Flashing the Binaries.

Steps

7. Select the SSID identification for the Hackerboard and press Enter (recommended to use a different one if several Puzzlebots are being used simultaneously).
8. Select the password for the Hackerboard's Wi-Fi Network and press Enter (recommended to use a different one if several Puzzlebots are being used simultaneously).
9. Wait until the program finish flashing.
10. The screen must turn on.

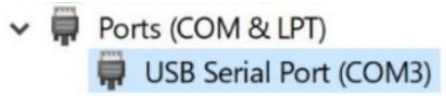




Troubleshoot

Troubleshoot (Drivers)

- Drivers are usually installed automatically by Windows and Ubuntu even for the Virtual Machines.
- How do I know if the drivers are properly installed (Windows)?
  - Plug the Puzzle-Bot into the USB port.
  - Go to Start › Device Manager
  - The Serial port should appear as shown in the following figure (The COM port may vary).



- If the computer cannot find the drivers, download the drivers from the following link

  https://ftdichip.com/drivers/vcp-drivers/

- Verify that the USB cable is a data cable and not only a power cable!

- Scroll down and download the executable setup as shown in the following figure

Operating System	Release Date	X86 (32-Bit)	X64 (64-Bit)	PPC	ARM	MIPSII	MIPSIV	SH4	Comments
Windows*	2021-07-15	2.12.36.4	2.12.36.4	-	-	-	-	-	WHQL Certified. Includes VCP and D2XX. Available as a setup executable Please read the Release Notes and Installation Guides.
Linux	-	-	1.5.0	-	-	-	-	-	All FTDI devices now supported in Ubuntu 11.10, kernel 3.0.0-19 Refer to TN-101 if you need a custom VCP VID/PID in Linux VCP drivers are integrated into the kernel.
Mac OS X 10.3 to 10.8	2012-08-10	2.2.18	2.2.18	2.2.18	-	-	-	-	Refer to TN-105 if you need a custom VCP VID/PID in MAC OS
Mac OS X 10.9 to 10.14	2019-12-24	-	2.4.4	-	-	-	-	-	This driver is signed by Apple

Before Installing the drivers!!

- Unplug the Puzzlebot from the computer.
- Unzip the drivers and run the setup (some computers must be restarted after the installation).
- Plug the Puzzlebot back into the computer.

Troubleshoot

Troubleshoot (Drivers)

- Some Hackerboard have a different USB-UART chip the CP210x.
- Drivers are usually installed automatically by Windows and Ubuntu even for the Virtual Machines.
- Verify if they are installed by following the steps in the previous slide.
- Verify that the USB cable is a data cable and not only a power cable!.
- If the computer cannot find the drivers, download the drivers from the following link

https://www.silabs.com/developers/usb-to-uart-bridge-vcp-drivers?tab=downloads

Before Installing the drivers!!

- Unplug the Puzzle-Bot from the computer.
- Unzip the drivers and run the setup (some computers are required to be restarted after the installation).
- Plug the Puzzle-Bot back into the computer.

A troubleshoot guide can be found here.

Troubleshoot

Troubleshoot (Drivers)

- My computer still not recognize the drivers even after the installation
- Plug the Puzzle-Bot into the USB port.
- Go to Start > Device Manager.
- Look for the USB Serial Converter as shown in the following picture.

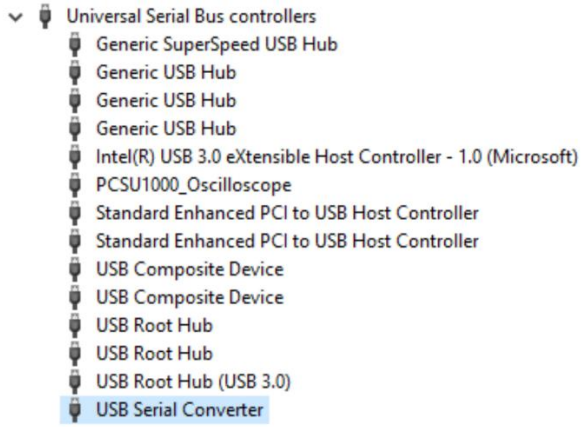


FIGURE: USB SERIAL CONVERTER

- Right Click to Properties > Advanced Tab.
- Make sure the Load VCP box is checked.
- Reconnect the Puzzle-Bot to the computer.

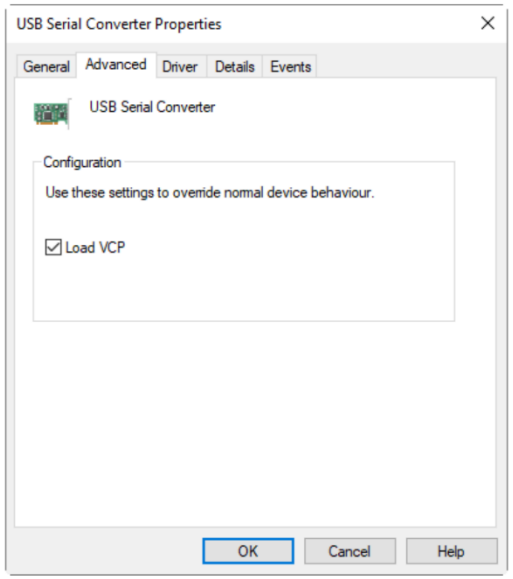


FIGURE: VCP PORT

Hackerboard

Connections and configurations for the Jetson Nano and Rpi

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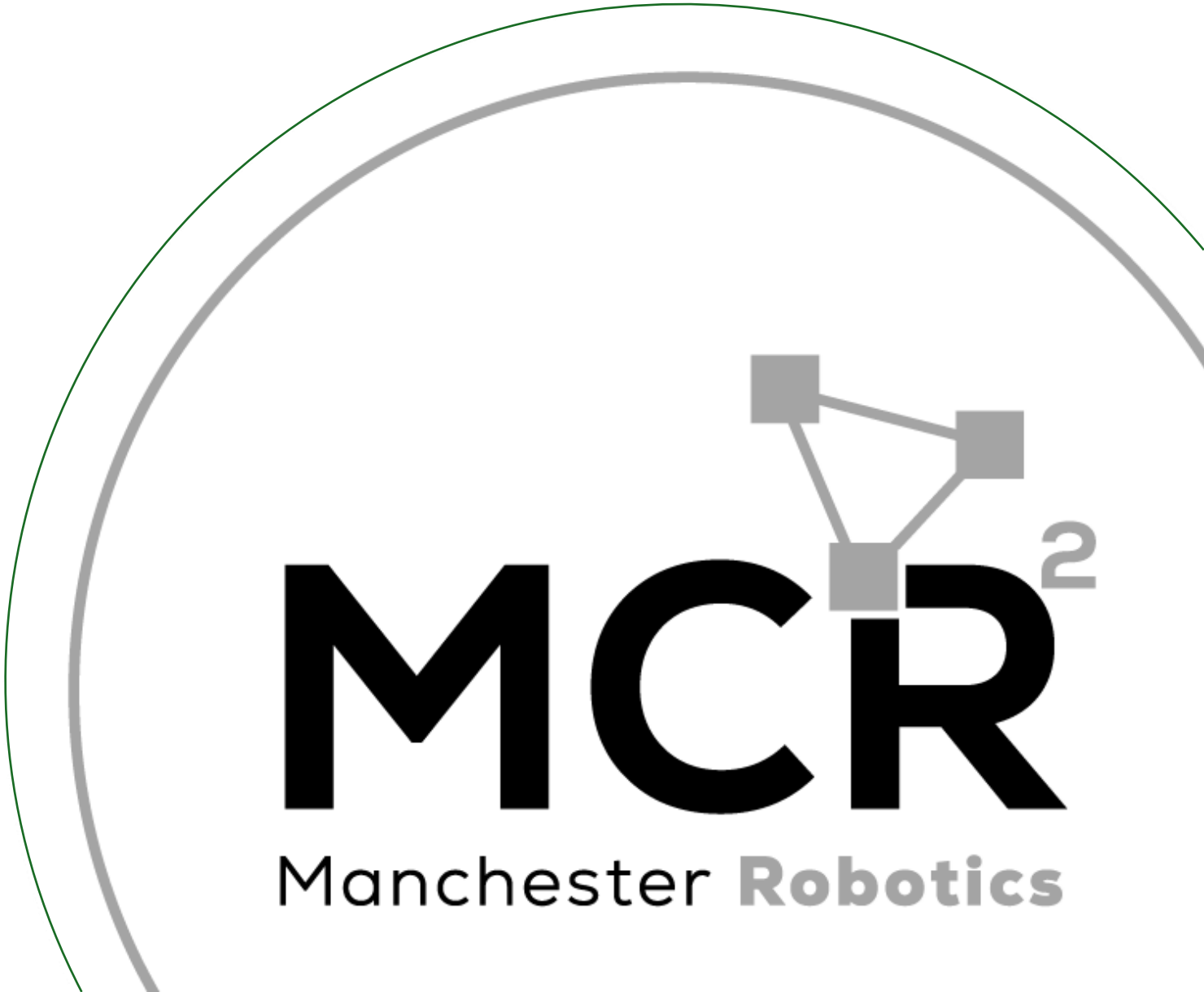
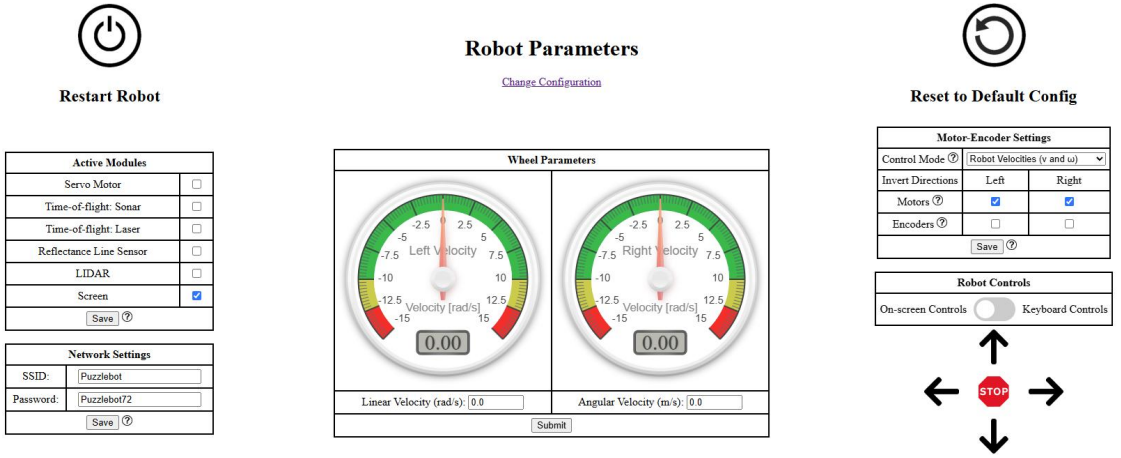


Connecting to the Hackerboard

Puzzlebot Web Interface

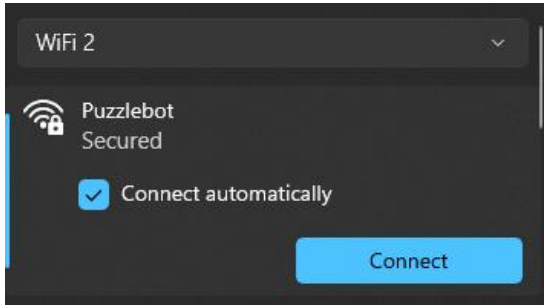
The Puzzlebot has a web interface allowing it to configure and test the different sensors and actuators equipped in the robot.

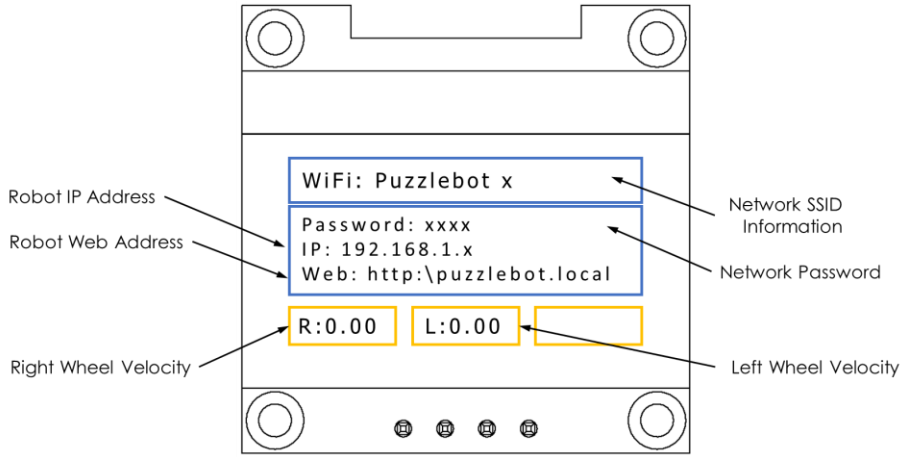
The website offers a visual interface that enables the user to configure and test various internal settings of the robot, including motor controllers, sensor activation, actuator activation (if applicable), and communication with external computing units.

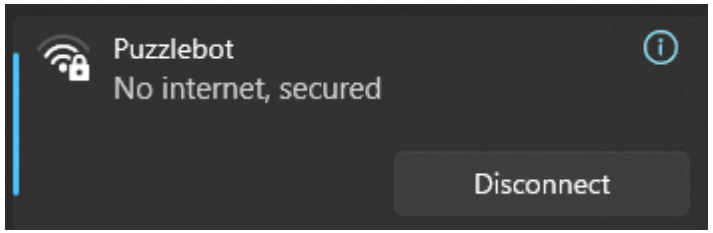


Connecting to the Hackerboard

1. Go to the Wi-Fi Network connections.
2. Connect to the Wi-Fi network created by the Puzzlebot by choosing the Puzzlebot Wi-Fi network of the robot you want (Puzzlebot x), then select Connect.
3. Type the network password that you selected when flashing (shown on the LCD Display), and then select Next.
4. Once Connected the network should say “No internet, secured” (Windows only).





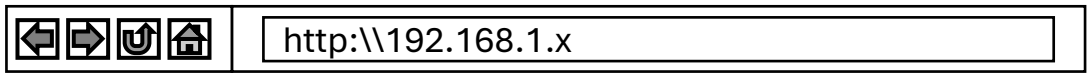


Connecting to the Hackerboard

Connecting to the Puzzlebot Web Interface

1. Open a web browser

2. Type the following IP address on the search bar



3. The Puzzlebot Robot Parameters interface should load.

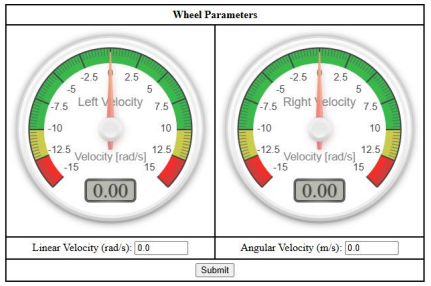
Restart Robot

Active Modules	
Servo Motor	☐
Time-of-flight: Sonar	☐
Time-of-flight: Laser	☐
Reflectance Line Sensor	☐
LIDAR	☐
Screen	☑
Save	

Network Settings	
SSID:	Puzzlebot
Password:	Puzzlebot72
Save	

Robot Parameters

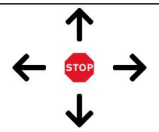
Change Configuration



Reset to Default Config

Motor-Encoder Settings		
Control Mode	Robot Velocities (v and ω)	
Invert Directions	Left	Right
Motors	☑	☑
Encoders	☐	☐
Save		

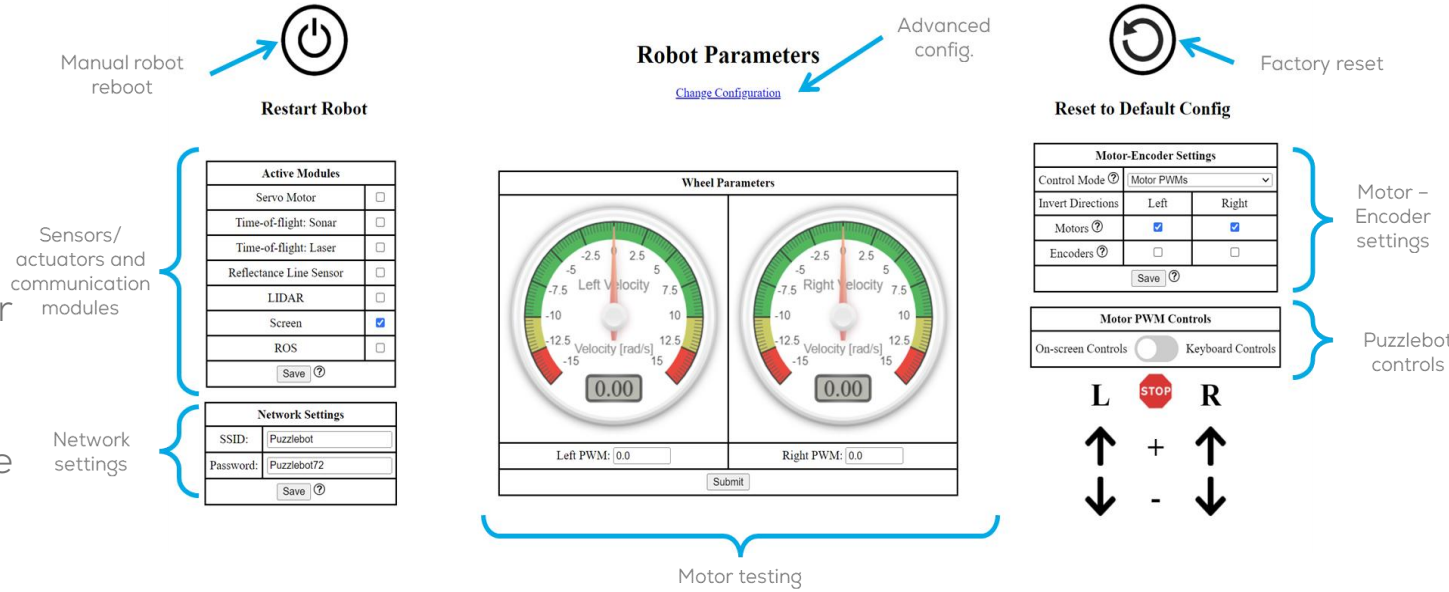
Robot Controls	
On-screen Controls	Keyboard Controls



Configuring the Hackerboard

- **Manual robot reboot:** Manually reboots the Hackerboard.
- **Factory Reset:** Reset all the configurations to factory configurations.
- **Network settings:** Configuration of the SSID and password of the Puzzlebot. Useful when multiple Puzzlebots are being used.
- **Puzzlebot controls:** Simple Puzzlebot controls for the user to move the robot forward, backwards or turning.
- **Sensor/actuators and comms. modules:** Activation of the sensors/actuators if included connected to the Hackerboard. The sensors and actuators in this section can connect to ROS. More information on the Puzzlebot Manual.

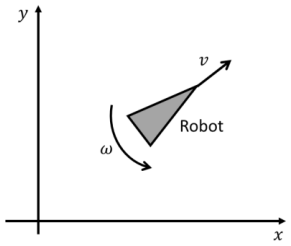
**This slide is only for informative purposes and is not required for basic Jetson connection.



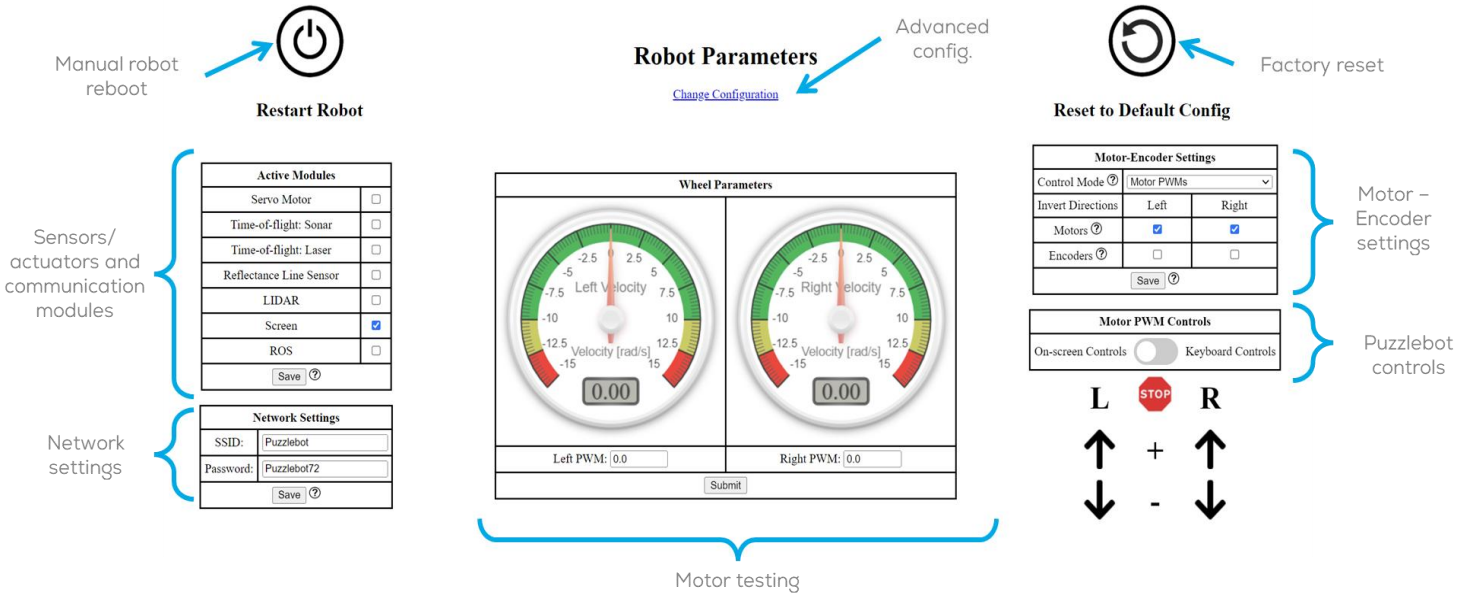
*Moving the cursor over the question marks (?) displays more information about each configuration parameter.

Configuring the Hackerboard

- **Advanced configuration:** Manually configure all aspects of the Puzzlebot. **Warning! adjusting the parameters of the Puzzlebot could result in significant malfunctions.**
- **Motor-Encoder Settings:** Motor and Encoder configurations.
  - Motor PWM: Values in the range of [-1, 1] (No control)
  - Wheel velocities (ωL and ωR): Wheel velocities (Inner PID control used)
  - Robot Velocities (v and ω): Linear and angular speed of the robot.



- **Motor testing:** Manually send values to the motors for testing. The values sent depend on the Control Mode.



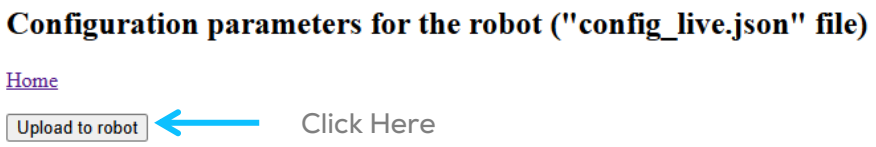
Connecting to the Hackerboard

Configuring ROS Serial communication

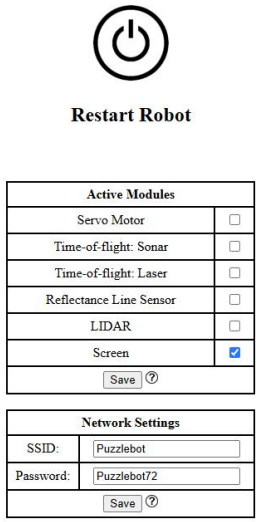
1. Click on the “Change Configuration” link on the top. This will take you to another website were all the internal configurations of the robot can be seen.

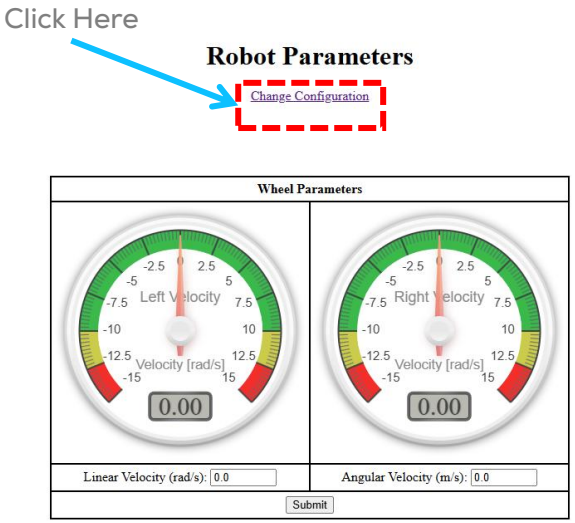
2. In the section “Ros” Change the value of “CommType” to “2”.

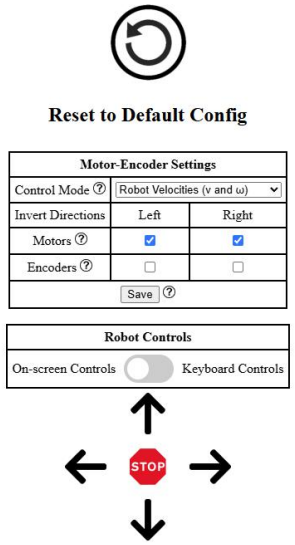
3. Upload to the robot by pressing the button “Upload to the robot” at the top of the webpage.



4. The Hackerboard will restart








```
"Ros": {
  "MasterIP": [
    192,
    168,
    1,
    2
  ],
  "CommType": 2,
  "MasterPort": 9999,
  "Dt": 0.005
},
```

Connecting to the Hackerboard

Configuring the Hackerboard

4. The ROS topics to be published by the Puzzlebot depend on the “Control Mode” Selected.
    - See table in next slide.
5. Having selected the Control Mode and activated the ROS Module, press Save and disconnect from the robot.

Motor-Encoder Settings		
Control Mode ⓘ	Robot Velocities (v and ω)	
Invert Directions	Left	Right
Motors ⓘ	☑	☑
Encoders ⓘ	☐	☐
Save ⓘ		

Connecting to the Hackerboard

Control Mode	Description	Topic	Type	Information
Motor PWMs	Wheel PWM voltage signal	/ControlL, /ControlR	std_msgs/Float32	data: PWM duty cycle for each motor [-1,1]
Wheel velocities (ωL and ωR)	Wheel angular velocities setpoint (PID control)	/VelocitySetR, /VelocitySetL	std_msgs/Float32	data: Control Set Point for wheel velocities
Robot Velocities (v and ω)	Linear and Angular Velocities (PID control)	/cmd_vel	geometry_msgs/Twist	linear x: Linear speed of the robot y: Not used z: Not Used angular: x: Not Used y: Not Used z: Angular Speed of the robot