Robot@Factory

Lite

Provided kit assembly manual

Author List

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SPR + FEUP + IPB + INESC TEC

Provided kit assembly manual

PORTO

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Manual made to help the robot's assembly to the participants of the Robot@Factory Lite competition, that have chosen to use the designed kit by the competition organizers. The kit with the designed parts, bill of materials, electric schematic, connections and simulator with pre-programed hardware in the loop can be found at:
https://github.com/P33a/RobotAtFactoryLite .

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List of Materials

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DC Motor	2
Wheels	2
RFID Reader	1
Line Sensor	1
Electromagnet	1
Caster Wheel	1
Battery support	2
Motors driver	1
Arduino Nano	1
Arduino Nano shield	1
Lithium battery	2
Step down converter	1
Micro switch	1
Connection Wires	x
Battery Charger	1
Wood screw 2.5X12 mm	28
Plain female screw 3X10 mm	4
Wood screw 3X15 mm	4
Female screw 3X30 mm	4
Female screw 3X20 mm	2
Female screw 3X6 mm	1
Wire wrap	2
Screw nut 3 mm	11
Power Button/Switch	1
Heat Shrink Sleeves	x
FDP3682	1
3D Printed Parts	Quantities
raflite_base	1
raflite_RFID	1
raflite_RFID_support	1
raflite_spacer	2
yellow_motor_support	2
motor_driver_support	1/opt

https://www.botnroll.com/pt/interruptores-botoes/2353-botao-de-pressao-para-alimentacao-breakout-.html

ROBOT'S ASSEMBLY

This manual will cover the assembly of the robot step by step. Note that, maybe it will be necessary to widen up just a little bit the holes in the parts because of imprecision from the 3D printer. After the material needed is gathered and printed, the first thing to do is to screw four pillars to the base of the robot. It will be needed four 2.5X12 mm wood screws. After that, screw the front sensors support to the front of the base. These steps can be seen in Figures 1, 2, 3 and 4.

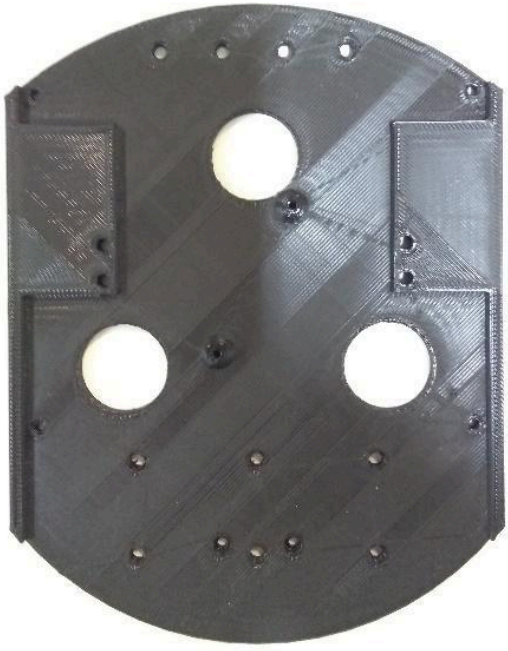


Figure 1. Robot's base.

Figure 2. Four pillars positions.

Figure 3. RFID support assembly.

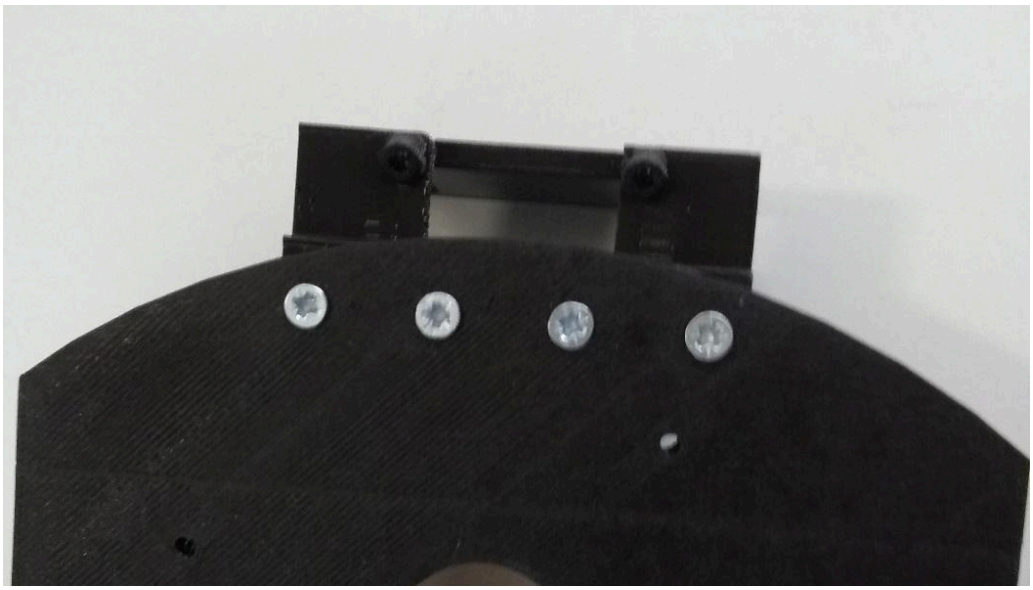


Figure 4. Robot’s base bottom view with the front support.

The next step is to screw the microcontroller Arduino Uno to the upper robot's base. For this procedure it is necessary four 2.5X12 mm wood screws. See Figures 5 and 6.

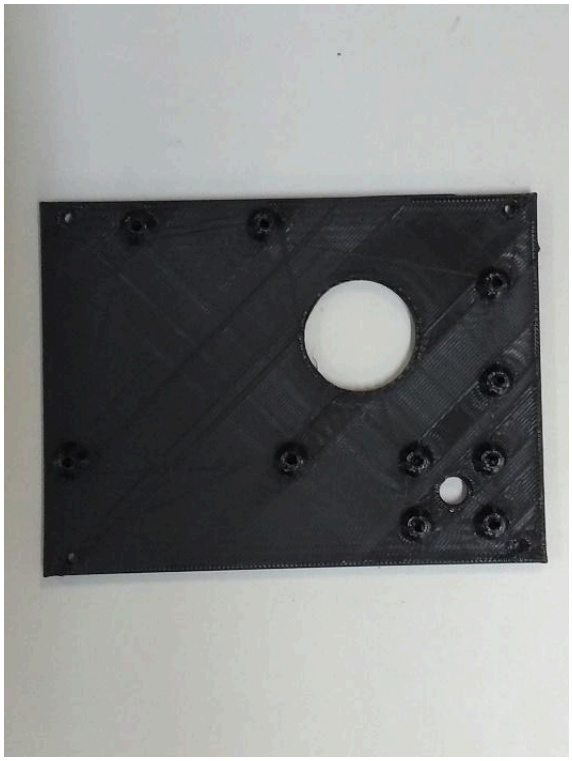


Figure 5. Robot's upper base.

Figure 6. Arduino’s assembly to the base.

Now, the task is to screw the RFID integrated circuit to the RFID part with four 2.5X12 mm wood screws. It’s recommended to weld male pin headers to the IC. Soon after, with the spacers in the list of materials section, screw the RFID part with two female 3X20 mm screws coupled with the correspondent screw-nuts to the RFID support part seen in Figure 3. This task can be seen in Figures 7 and 8.

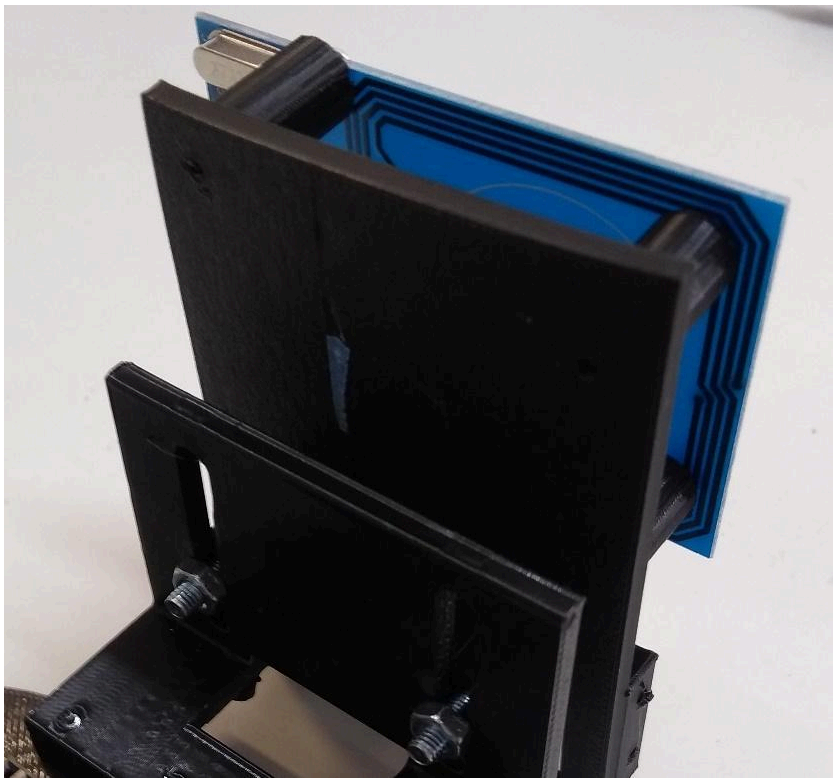


Figure 7. The assembly of RFID IC and support.

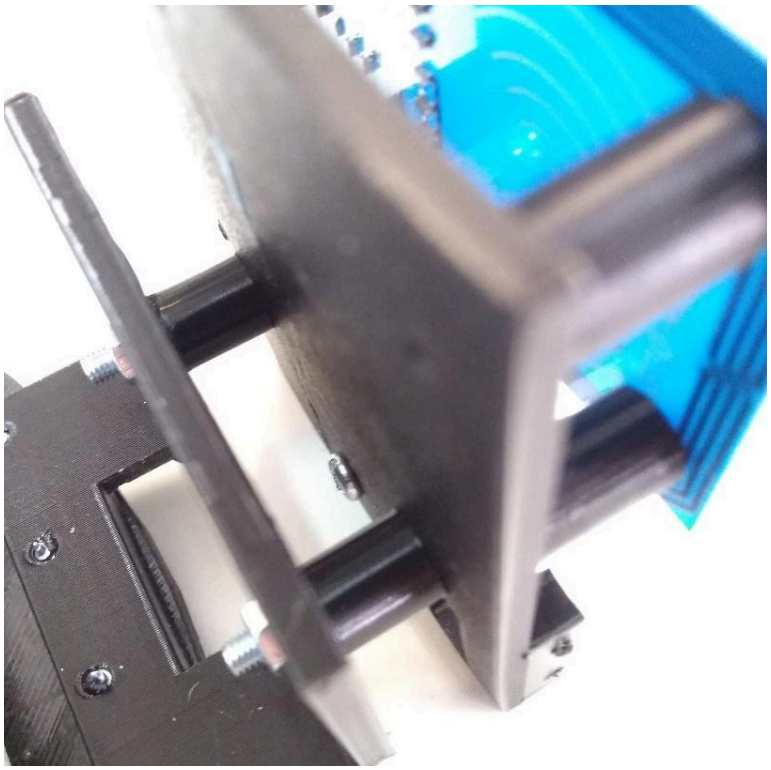


Figure 8. Spacers and female screws with screw-nuts.

After that, screw the microswitch with roller to the RFID part with two 2.5x12 mm wood screws. It can be seen in Figures 9 and 10. It's necessary to weld the two wires with heat shrink sleeves, this way there will be no danger to short circuits. Additionally, as shown in the schematic, the yellow wire has a 1 kΩ resistor in series, as can be seen in Figure 11 pointed by the green arrow. In addition, pay attention that there's 2 output wires welded together after the resistor. This was made because we are using the same digital pin both for the microswitch and the MOSI RFID pin, in this way, later in the connection phases the black wire will go to the eleventh digital pin in the Arduino and the blue wire will go to the RFID MOSI pin. The reason for the resistor is that, when the switch is activated, without the resistor, we would not be able to communicate with the RFID Reader. However, with the resistor, the pin 11 and MOSI will not be grounded.

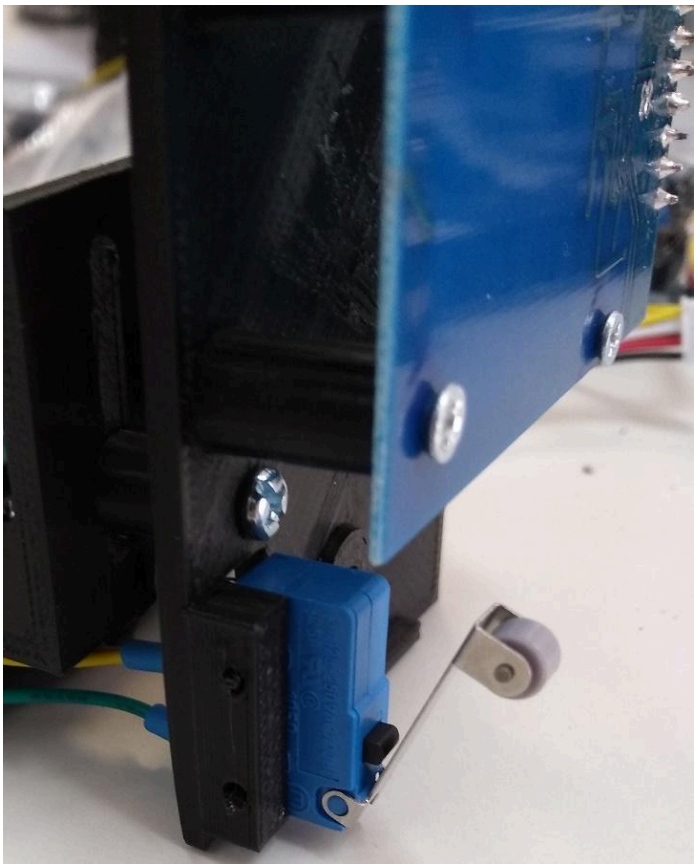


Figure 9. Microswitch position.

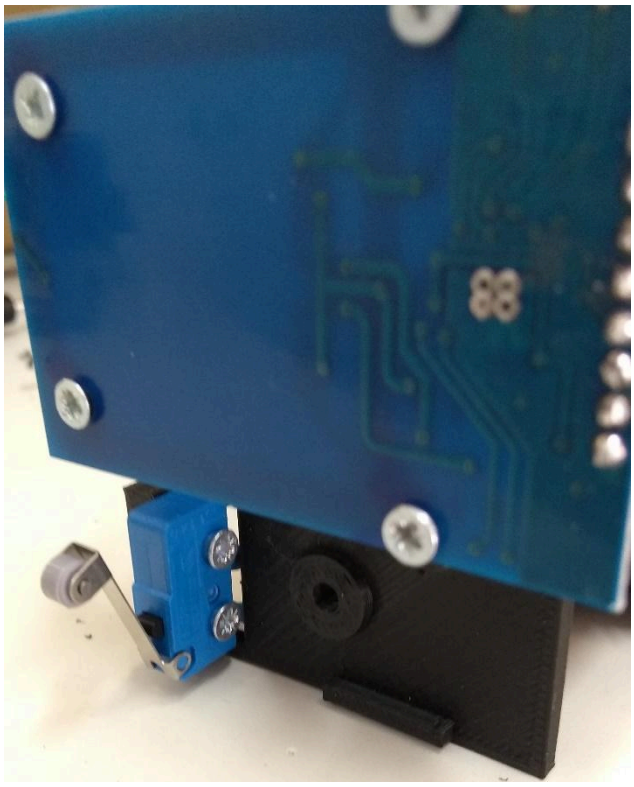


Figure 10. Microswitch assembly.

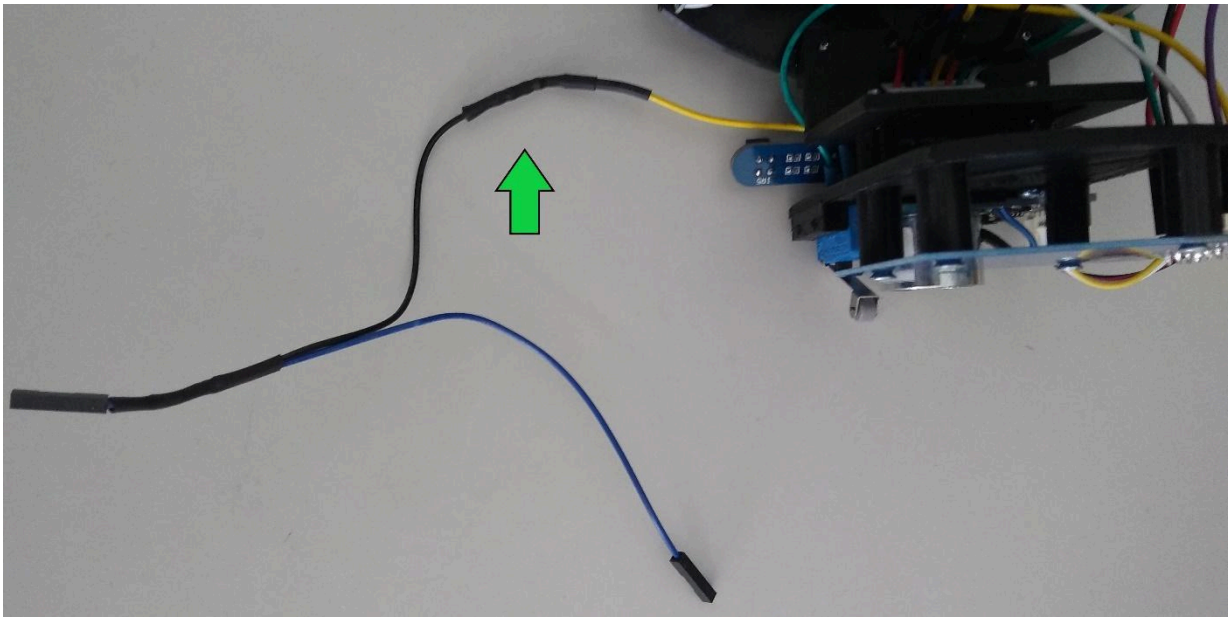


Figure 11. Welded wires of the switch.

Next, to assemble the electromagnet, first remove the screw from the IC, as seen in Figure 12.

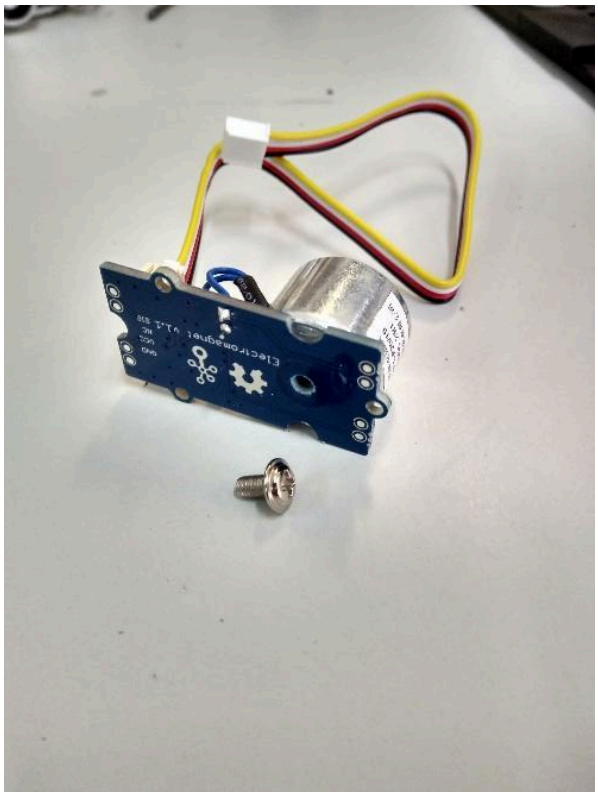


Figure 12. Electromagnet.

After this, screw the IC to the RFID part as seen in Figure 13.

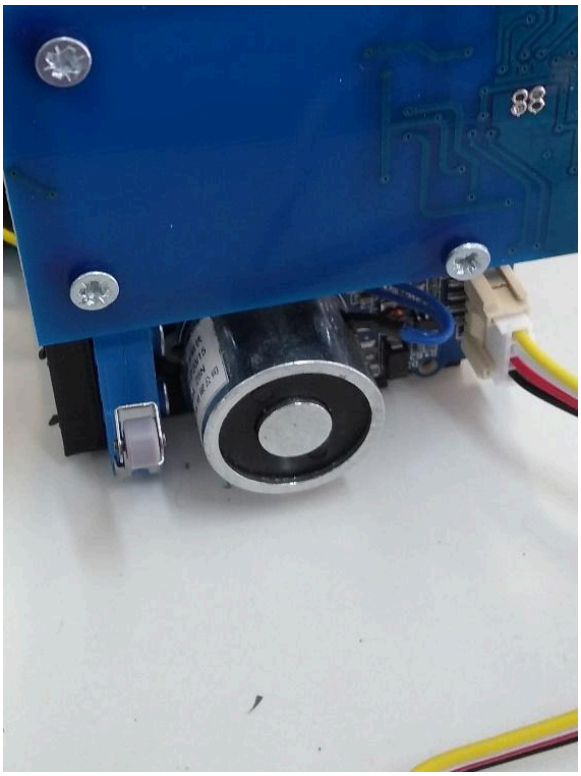


Figure 13. Electromagnet assembly.

Afterwards, screw the infrared line tracking sensor to the bottom of the RFID support part as seen in Figures 14 and 15. It is necessary two 2.5X12 mm wood screws for the task.

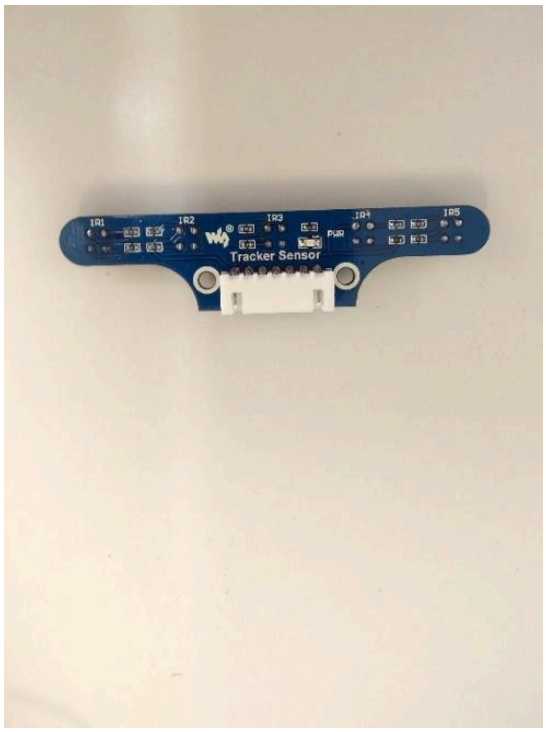


Figure 14. Infrared line tracking sensor.

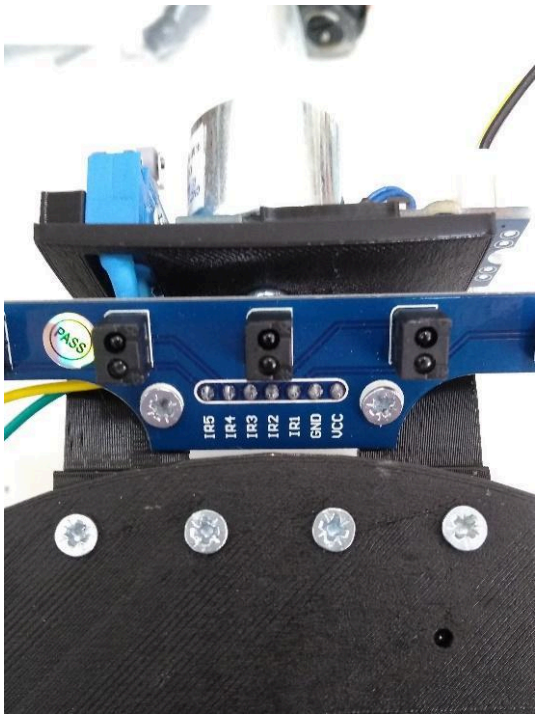


Figure 15. Bottom view of the front support.

Later, screw the motor support parts with two 3X15 mm wood screws per support. The location can be seen in Figures 16 and 17. It was used wood screws, for better attrition.

Figure 16. Motor support.

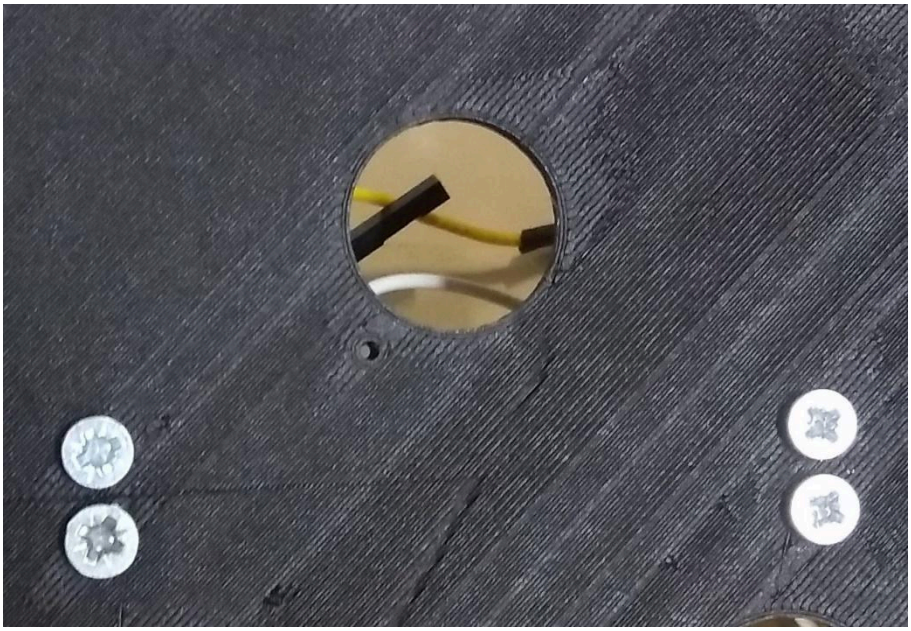


Figure 17. View of the screw position for the motor support.

The next step is to screw the battery supports to the base. It is necessary four plain 3X10 mm female screws, attach the respective screw nuts from below the base. The procedure can be seen in Figure 18. Additionally, pay attention that the batteries support is welded in series, as shown in the electric schematic.

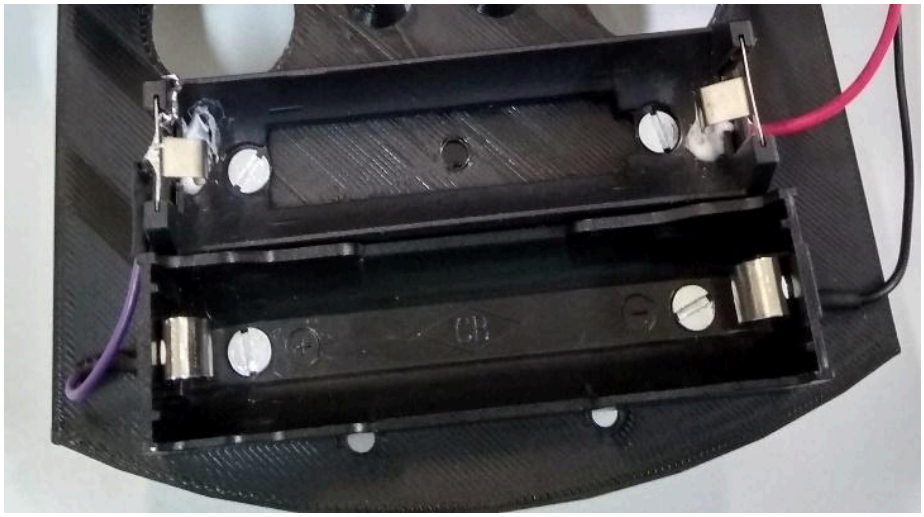


Figure 18. Batteries support.

Soon after, the figure below displays two electric schemes for the two different MOSFET channels. If you have a P channel, please follow the left scheme. In the other hand, if it is in hand a N channel field effect transistor, follow the right one. This circuit is to provide reverse electrical polarization protection to the robot. In this way, if the batteries are placed with the poles reversed, the FET will not enter the saturation state and, consequently, protecting the robot’s circuits.

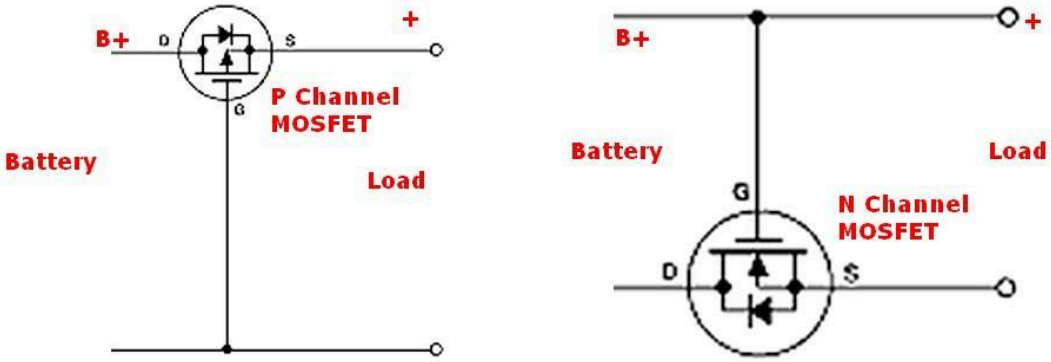


Figure 19. Electric schemes for the reverse polarization protection.

To install, make a 3 mm hole besides the battery's output and screw the transistor to the base of the robot with a 3X6 mm female screw and its respective screw nut as can be seen in Figure 20. After that, just weld the output batteries' wires as Figure 19 shows.

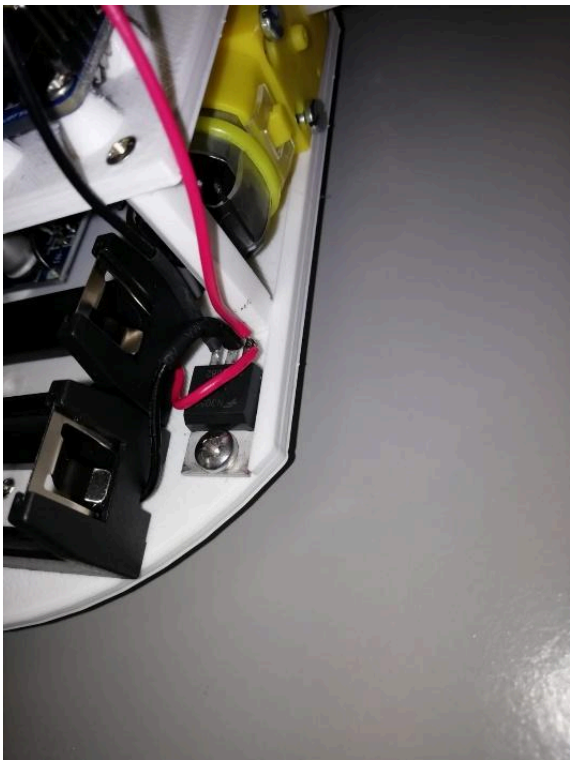


Figure 20. MOSFET's assembly.

Now, install the castor wheel in the way Figure 21 shows. The castor wheel comes with one bigger sphere and four smaller ones, two screws and the case. Just insert the bigger sphere into the case with the four smaller ones besides it. After that, just screw the case shut.

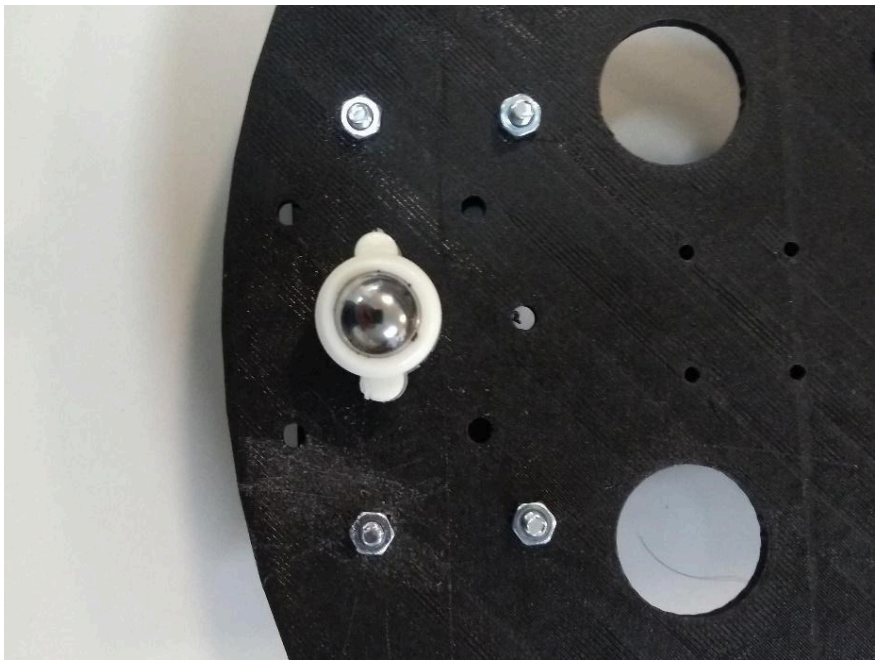


Figure 21. Bottom view of the base.

To install the motors, just use two 3X30 mm female screws with their respective screw nuts. Screw the motor to its support as shown in Figure 22. After that, just insert the wheel to the axis. Pay attention that you will need some pressure on the center of the wheel to push the fitting part to the axis. Do the same to the other side, shown in Figure 23. Use the wire wraps to tight up the motors' wires seen in both Figures below.

Figure 22. Left motor with wheel setting.

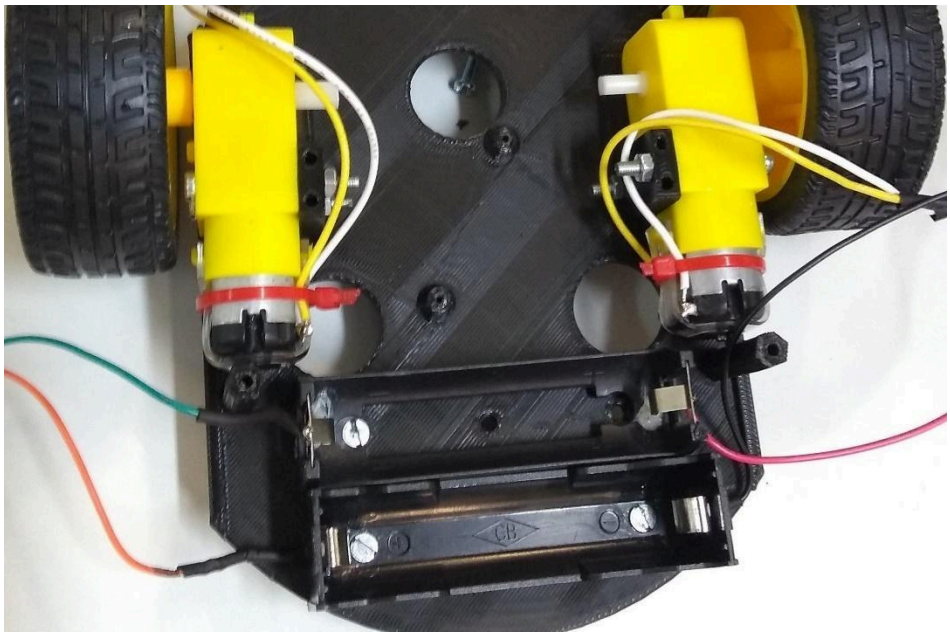


Figure 23. Top view of the robot.

To embed the dual motor driver, just screw it with two 2.5X12 mm wood screws. As we didn’t have the same model as in BoM, it was designed a support for our driver as seen in Figure 24. In addition, insert the expansions shield to the Arduino Uno as seen in Figure 25.

Figure 24. Dual motor driver.

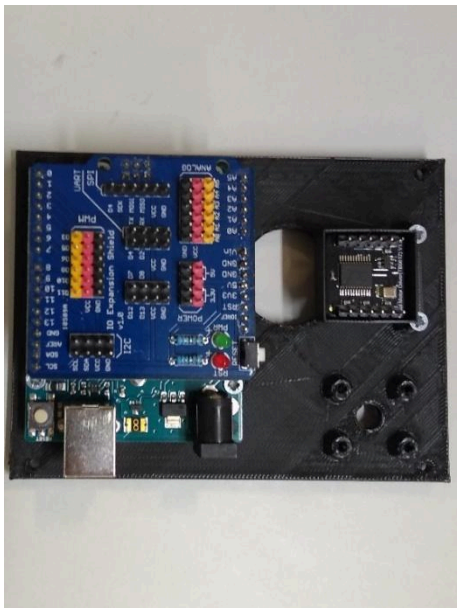


Figure 25. Expansion Shield.

Before assembling the stepdown, configure it to convert the DC input voltage to 5.2 V output. After this, the stepdown support assembly and position can be seen in Figure 26. Screw the part with two 2.5X12 mm wood screws as shown. It is recommended to first weld the input and output wires in the converter.

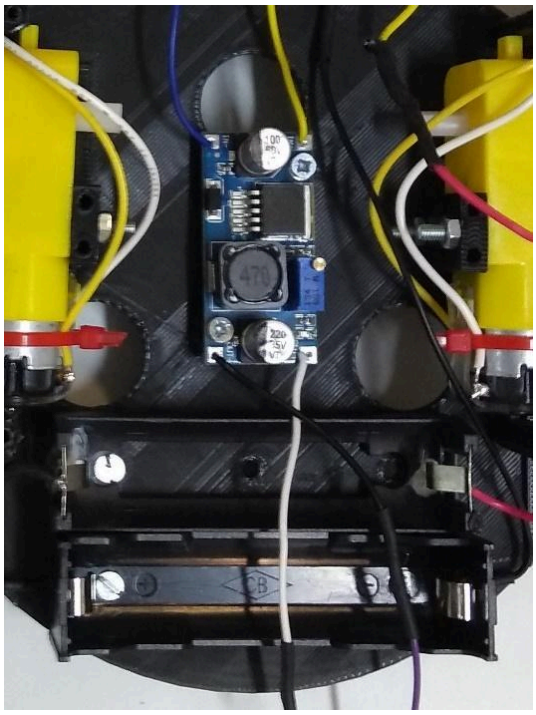


Figure 26. Stepdown converter.

Note that in Figure 27, there is more than one connector to the wire. This is done to supply the dual motor driver as well.

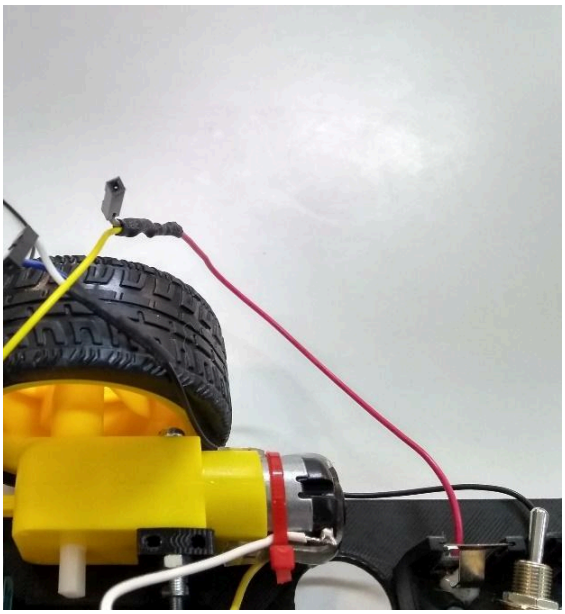


Figure 27. Battery to stepdown/driver wires.

Connect the IR sensor connector as shown in Figure 28.

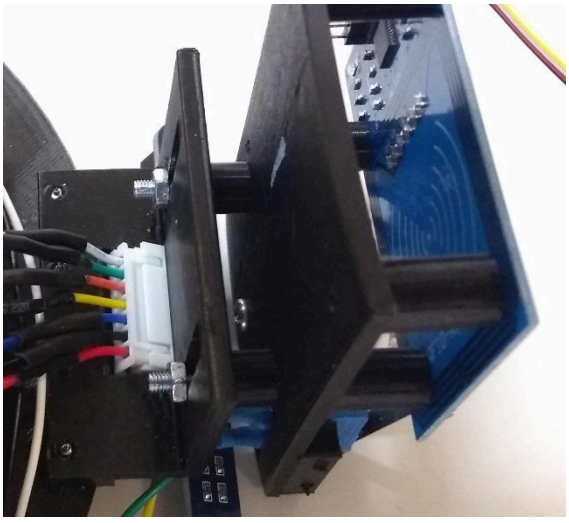


Figure 28. Infrared sensor connector.

This step is totally optional. In BoM document, there is a power button or a power switch to be bought. If it is chosen the first one, just screw with four 2.5X12 mm wood

screws in the position Figure 30 shows. However, if the latter is chosen, follow this guide. The power switch and its support seen in Figures 29 and 30 are available in the kit. If you choose to install, just weld the switch in series with the batteries as can be seen in Figure 29 and install with its support as in Figure 30. In Figure 29, the spot is a bit below of the driver.

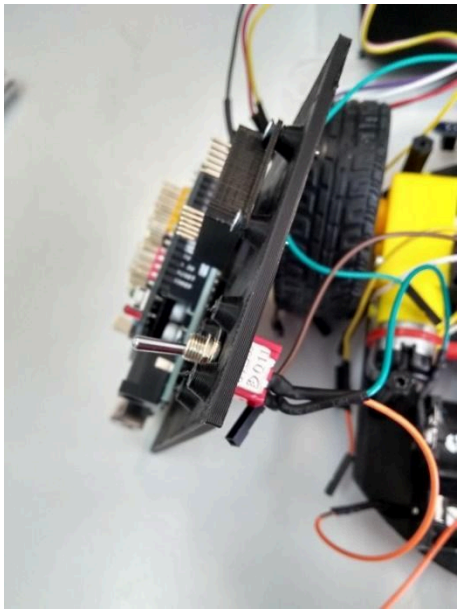


Figure 29. Power Switch.

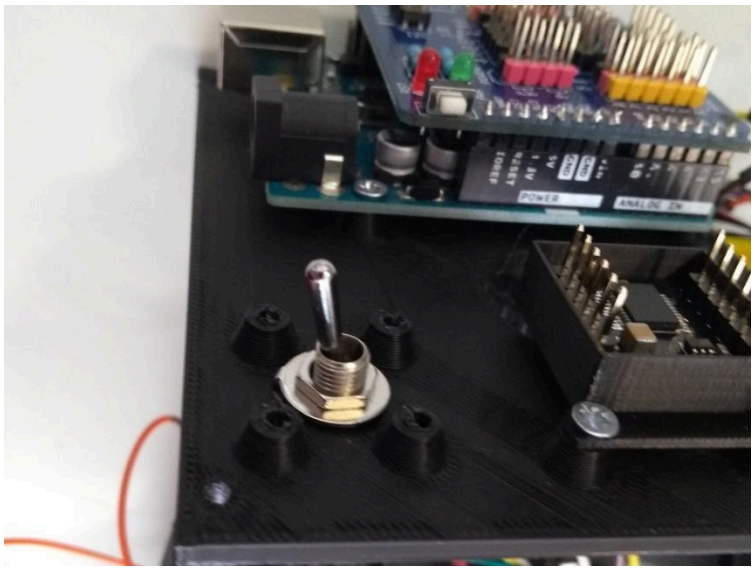


Figure 30. Power switch and its support.

After installing the switch, screw the top layer to the base of the robot using four 2.5X12 mm wood screws. This step can be seen in Figure 31. Now, the final steps are to make the correct connections to the expansion shield. Please, follow the electric schematic and the connections text file to guide you through out this phase. Remember that the RFID receptor is driven by 3.3 V not 5 V. In the other hand, both the electromagnet and the IR sensor are driven by 5V.

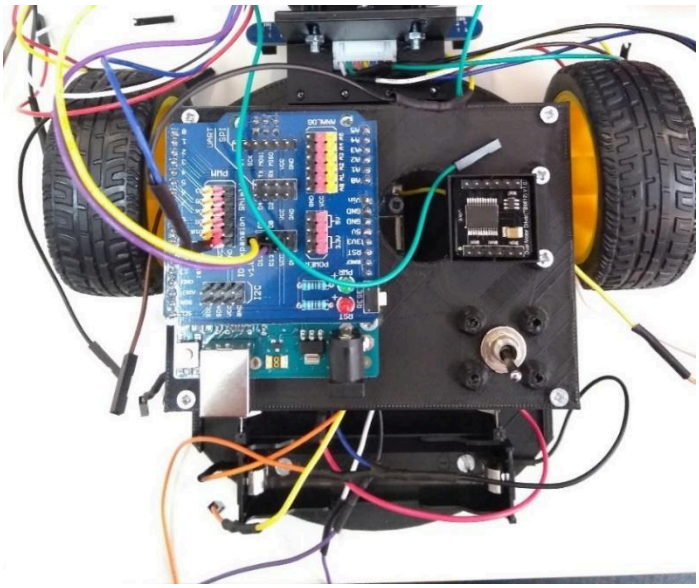


Figure 31. Top View of the Robot.

The robot after its connections, is shown in Figures 32, 33 and 34. Be cautious when connecting the VM, VCC, GND and the stepdown pins so that any component will be harmed by voltages above the secure threshold. Make sure that the output voltage of the stepdown is configured to 5.2 V. This way, the stepdown will drive the peripherals, not the Arduino.

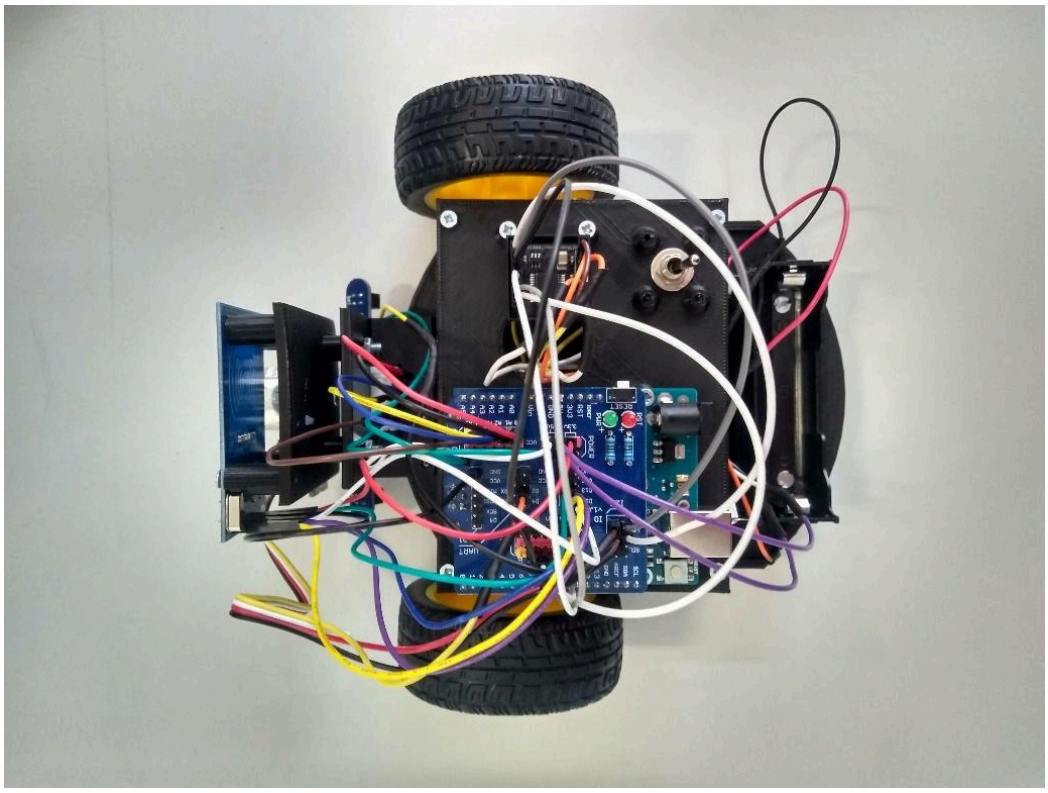


Figure 32. Robot's top view after its assembly.

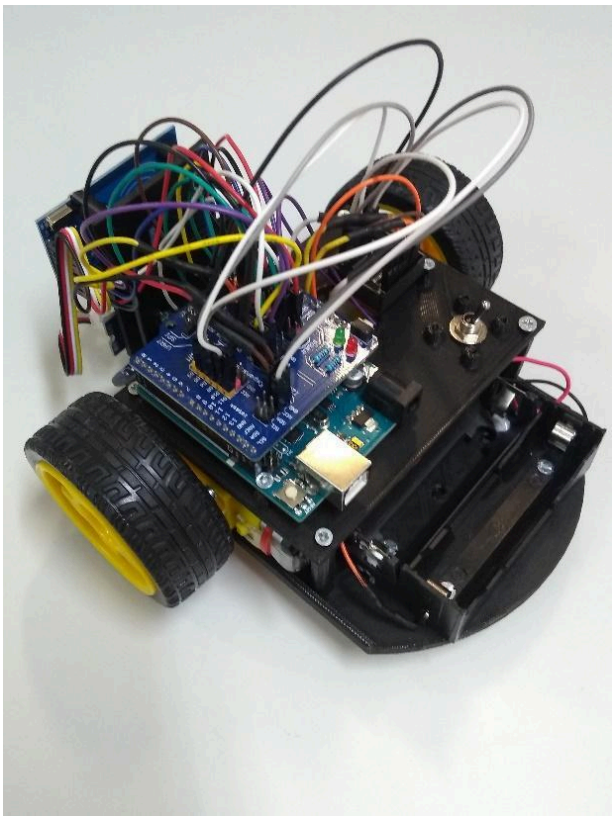


Figure 33. Isometric View of the Robot.

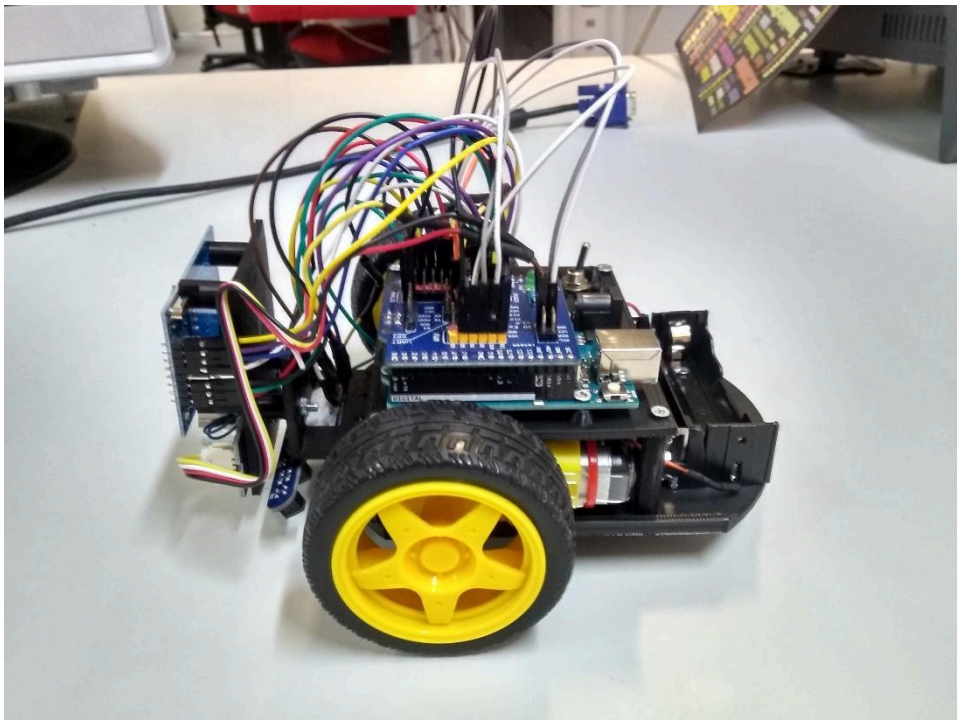


Figure 34. Robot's sideview after its assembly

ELECTRIC SCHEMATIC

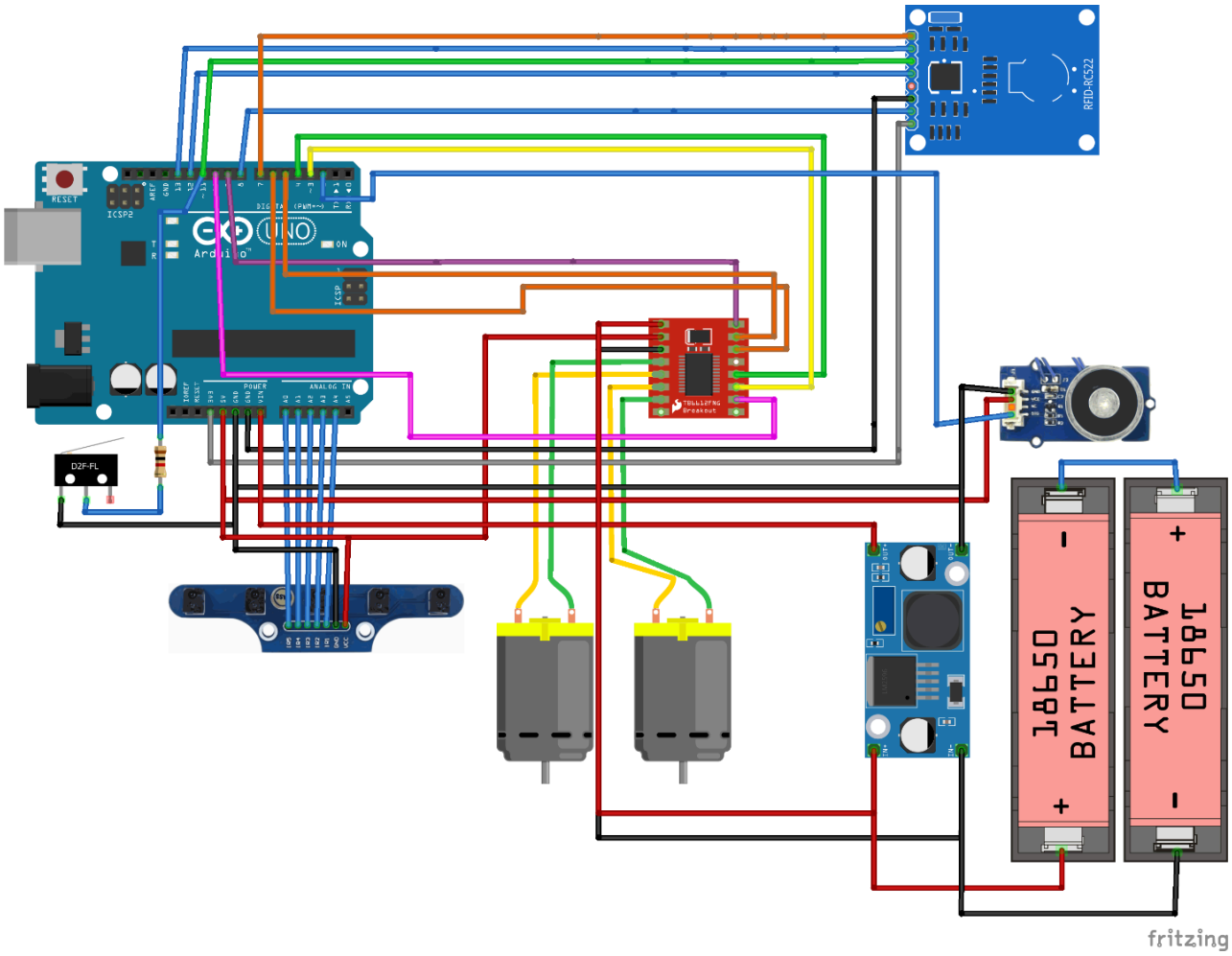


Figure 35. Electric Schematic.

Connections table

Microcontroller and its peripherals connections	
RFID	
SCK	13
MISO	12
MOSI	11
RST	8
SDA	7
IRQ	NC
GND	GND
3.3 V	3.3 V
IR Sensor	
IR5	A0
IR4	A1
IR3	A2
IR2	A3
IR1	A4
GND	GND
VCC	5 V/VCC
Motors A-Left B-Right	
PWMA	9
AIN1	6
AIN2	5
PWMB	10
BIN1	4
BIN2	3
MOTORA	Left motor wires
MOTORB	Right motor wires
VCC	5 V/VCC
VM	<12 V / Batteries wires
GND	GND
Solenoid	
SIG	2
VCC	5 V/VCC
GND	GND
Microswitch with roller	
Mid pole with resistor	11
Extremity pole	GND
Stepdown	
IN+	Battery +
IN-	Battery -
OUT+	5 V/VCC
OUT-	GND

Using motors with encoders

If motors with encoders are used, it is necessary to make a few adjustments. The RFID will have to be removed so that the encoders can be connected to the pins that were being used by the RFID.

The pillars and supports used for motors with encoders are slightly different (see Figure 36), so they will have to be replaced.

The new supports have holes for the screws aligned in a different way, so it will be necessary to drill a hole on each side of the bottom platform (see Figure 37). Also, a small cavity will have to be made in the bottom platform so that the encoders don't touch the platform (see Figure 38).

Some of the connections will be different too, namely for the microswitch, so please follow the connections table below.

Figure 36. New pillar and support.

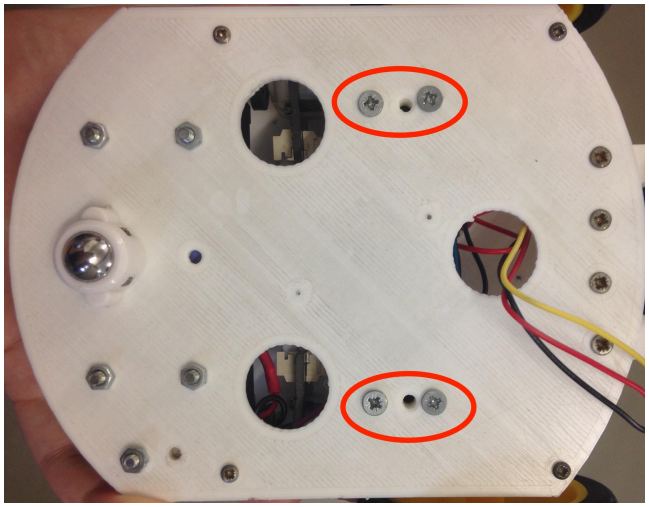


Figure 37. Screw position for the motor support

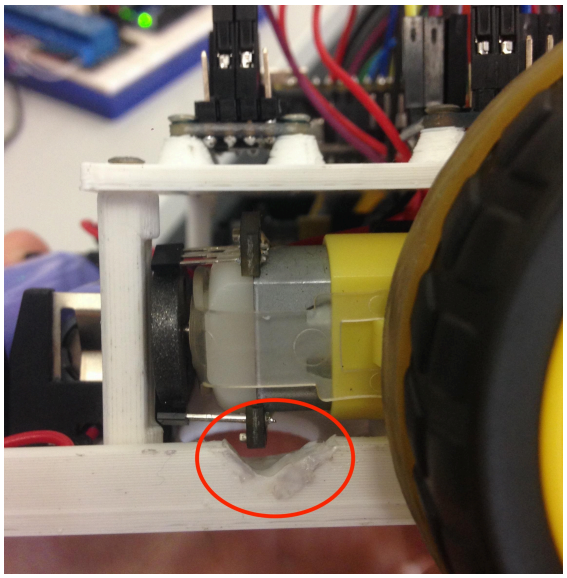
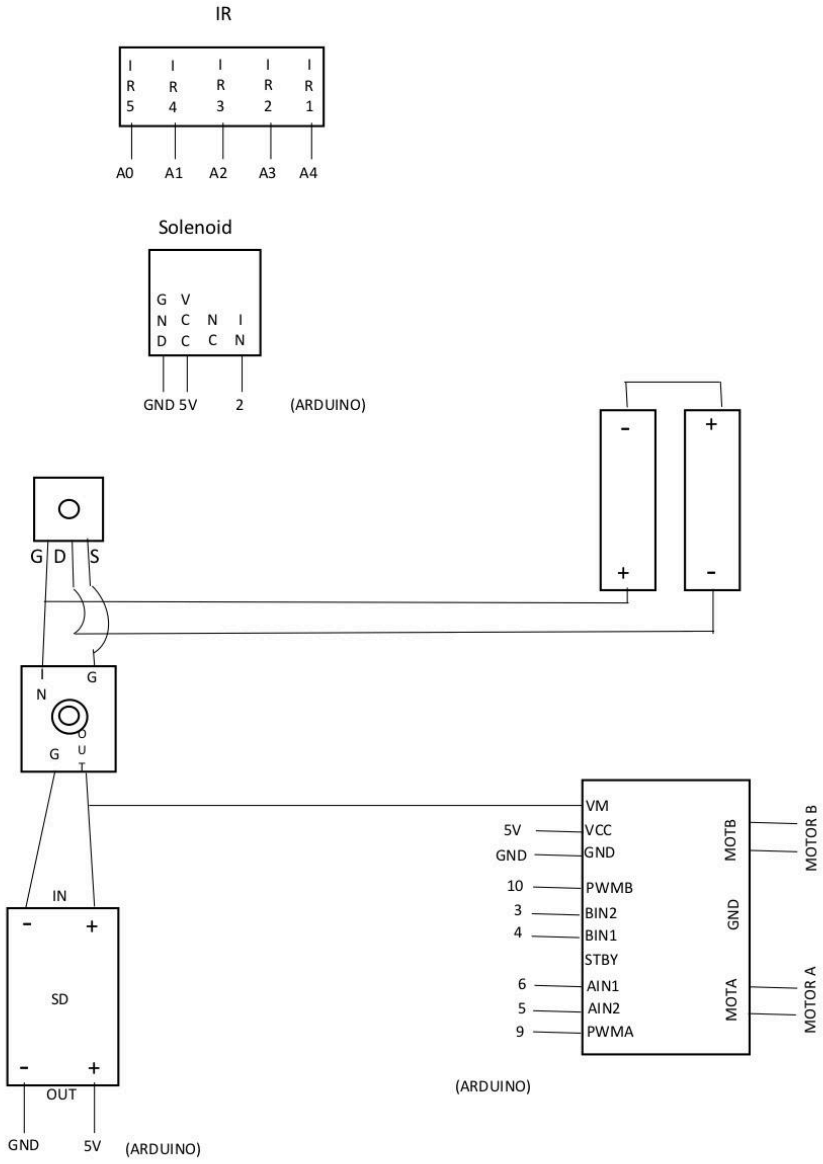


Figure 37. Cavity that will have to be made in the bottom platform

Microcontroller and its peripherals connections	
IR Sensor	
IR5	A0
IR4	A1
IR3	A2
IR2	A3
IR1	A4
GND	GND
VCC	5 V/VCC
Motors A-Left B-Right (robot's side)	
PWMA	9
AIN1	6
AIN2	5
PWMB	10
BIN1	4
BIN2	3
MOTORA	Left motor wires
MOTORB	Right motor wires
VCC	5 V/VCC
VM	<12 V / Batteries wires
GND	GND
ENC1_A (verde motor A)	8
ENC1_B (motor A)	7
ENC2_A (verde motor B)	12
ENC2_B (motor B)	11
Solenoid	
SIG	2
VCC	5 V/VCC

GND	GND
Microswitch with roller	
Mid pole with resistor	13
Extremity pole	5V/VCC
Stepdown	
IN+	Battery +
IN-	Battery -
OUT+	5 V/VCC
OUT-	GND



THE SHOP FLOOR GARAGES ASSEMBLY

The garages can be assembled by mounting them together with the assists of printed connectors as seen in Figures 36 and 37. Note that, to external walls have the same width as the internal ones, adjacent walls were coupled as well in Figure 37.

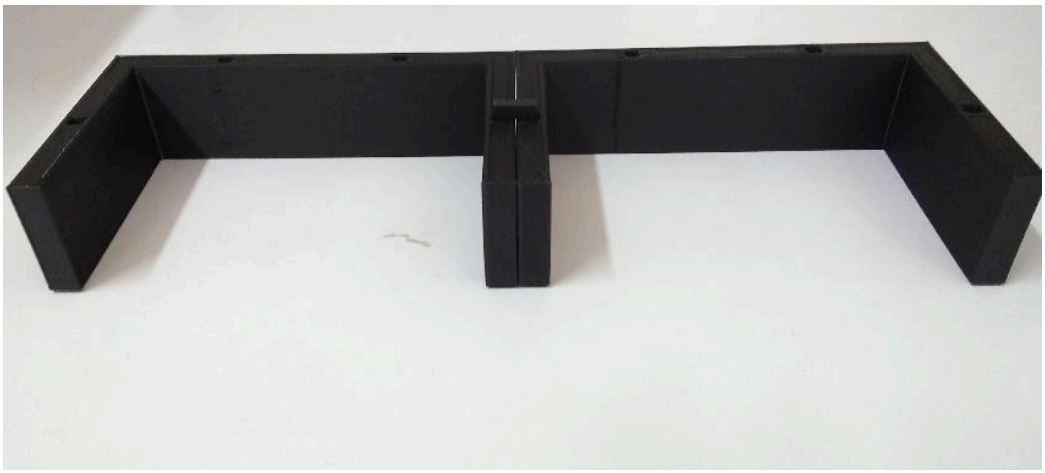


Figure 36. Garage assembly.

Figure 37. Three garages assembly topview.

See the garage position where the boxes will be put in Figure 38.

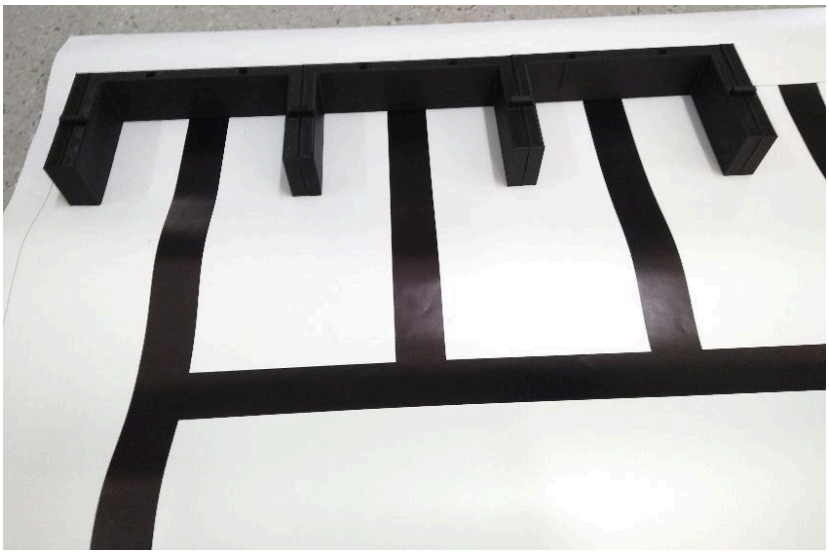


Figure 38. Garages position on the Shop Floor.

As for the machines, the assemble the parts as shown in Figure 39. The position of the machines is specified in the rules of the competition found in the site of the

competition as well as in the kit from git hub. However, as can be seen in Figure 40, the position of one IN/OUT garage from machine A is displayed.

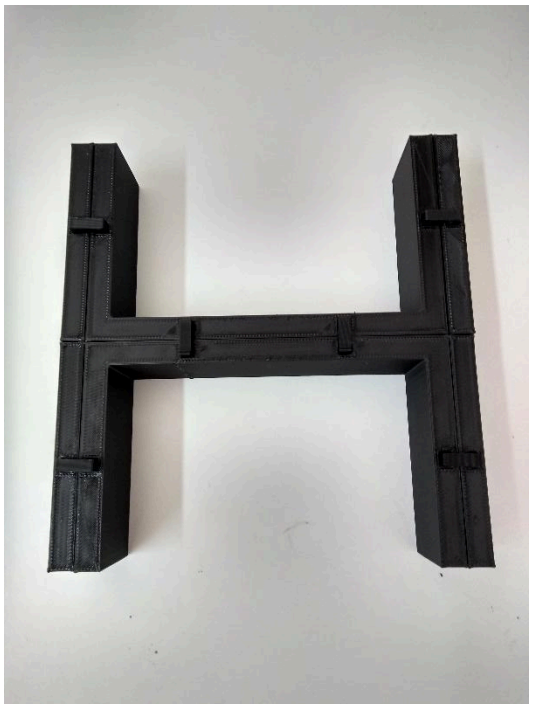


Figure 39. Part of Machine A.

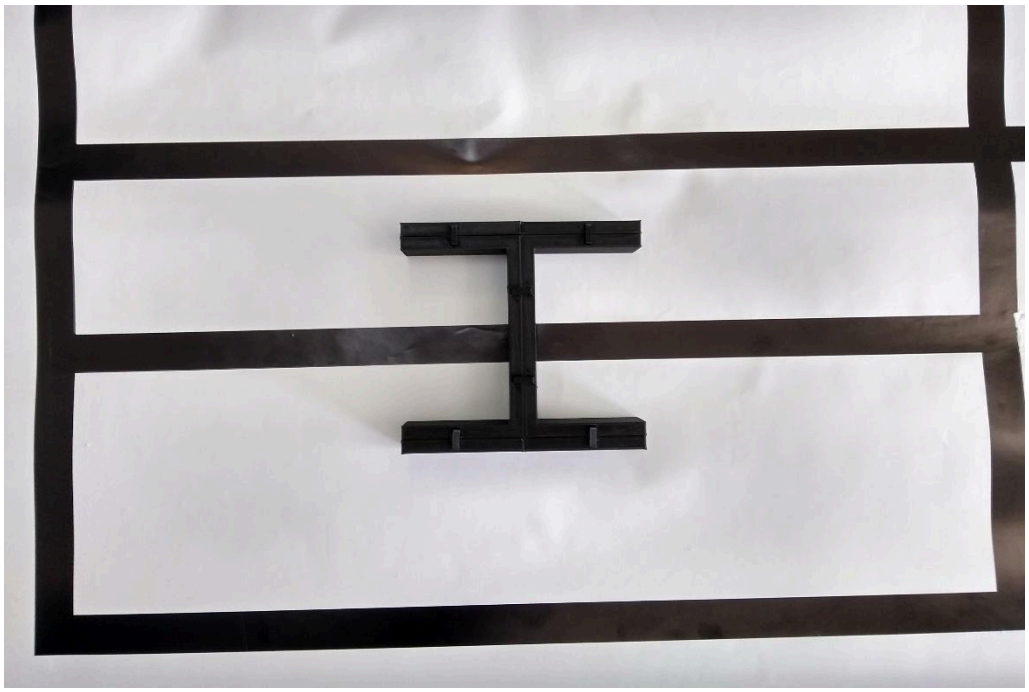


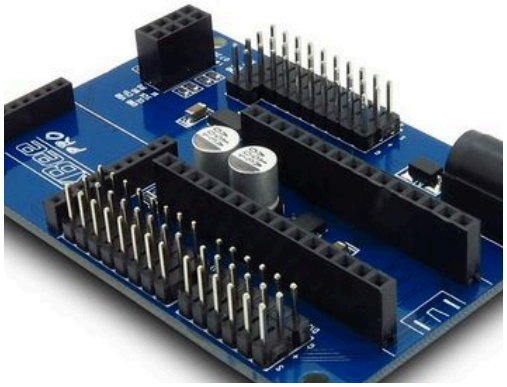
Figure 40. Position of Machine A.

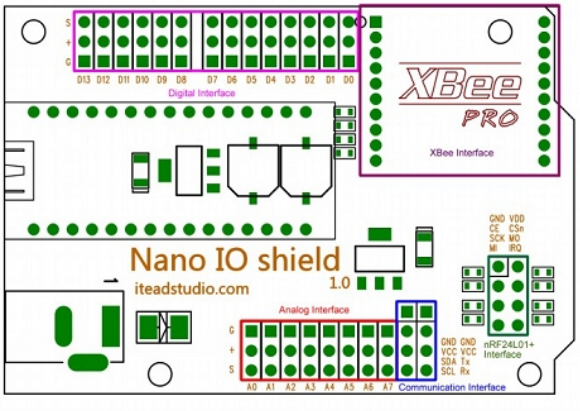
Corrections:

If using **Itead Nano Shield**

https://www.itead.cc/itead-arduino-nano-io-shield.html

https://www.itead.cc/wiki/Arduino_Nano_IO_shield





MUST CUT = BREAK resistor R8, near lower right corner (nRf interface) to allow the touch sensor in pin D11 to work. This has to do with eliminating pull down resistors meant for comms purposes (see SCH).