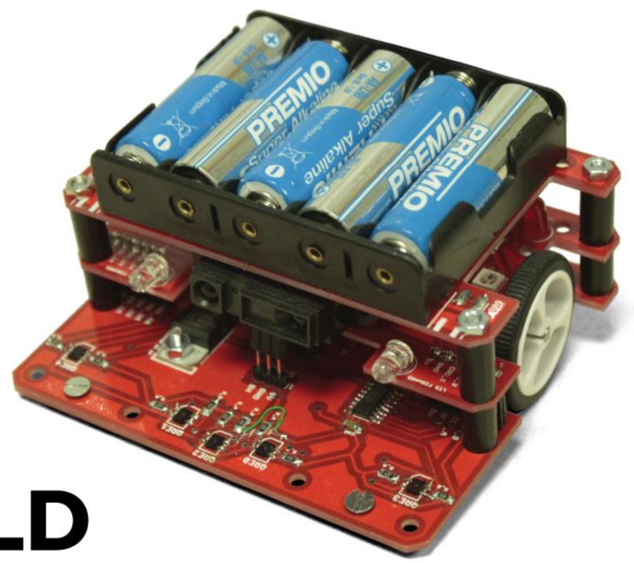
TALLER DE ROBÓTICA 2016

HELÉPOLIS



BUILD INSTRUCTIONS

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v0.1

LOG OF CHANGES		
REVISION	**DATE**	**CHANGE**
Rev 1	February 2016	Release

Contents

1. Introduction

This section contains general information about the *AETEL Helepolis* robot regarding its background, license information and creators.

1.1. What is AETEL Helepolis?

AETEL Helepolis is an Arduino based robot designed to perform various task as 10x10 cm Sumobot, Line follower, maze solver and Bluetooth control robot. Its aim is to be a trustworthy, robust robot for educational purposes useful as a first insight into autonomous machines and their problematic.

Its name is a reference to the amazing war machine called *Helepolis*, a great tower with several levels designed by the engineers of Alexander Magnus to assault the mighty walls of Rhodes. Its level based architecture inspired this solid PCB level based robot.

1.2. What is this document?

This document is a complete guide that covers the assembly, programing and user information. It is aimed to be used as the only document needed by the user to work on the *AETEL Helepolis*.

1.3. License Information

The *AETEL Helepolis* is released under an Attributtion-ShareAlike 4.0 International (CC BY-SA 4.0)[1]. Therefore, anyone is free to:

- Share – Copy and redistribute the material in any medium or format.
- Adapt – Remix, transform, and build upon the material for any purpose, even commercially.

1.4. About AETEL

AETEL Helepolis has been fully developed by Pablo de Miguel Morales[2] in collaboration with other members of AETEL, a student organization of the ETSIST UPM[3] (Madrid, Spain) and an IEEE Student Branch of Region 8[4]. Its objective is to create an appropriate environment in which students can learn and develop their technological projects and to divulgate the knowledge in electronics both for other students or external non-technical individuals.

To learn more about AETEL and their projects please visit our various sites:

AETEL Web: **http://upmsur.ieeespain.org/**

AETEL FB Page: **https://www.facebook.com/aetel.etsist/**

AETEL Twitter Profile: **https://twitter.com/aetel**

If you want to contact us please send an email to:

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[2] Pablo de Miguel Morales Linkledin Profile (nd), Pablo de Miguel Morales, https://www.linkedin.com/profile/view?id=296070600&trk=nav_responsive_tab_profile
[3] ETSIST UPM Main Page EN (nd), ETSIST UPM, https://www.euitt.upm.es/?idioma=EN
[4] IEEE Region 8 Main Page (nd), IEEE, http://www.ieeer8.org/

2. Hardware Guide

This section contains a complete guide of the assembly process, materials and tools needed.

2.1. Materials

The materials needed to build an *AETEL Helepolis* are:

Q.	ITEM	PACKAGE
02	Pololu Robot Wheel 32x7mm	-
01	Arduino NANO	-
01	USB-USBmini Wire	-
01	CI L293D Motor Driver	DIP16
01	Tactile PushButton Switch	OMRON 10
01	1x2 Microswitch	DP-02
01	Bluetooth Module	HC-06
02	RGB LED WS2812B	WS2812B
01	LM7806VC 6V 1.5-3A	TO220H
06	Capacitor 10µA	SMD 1206
01	Toggle Switch	TL3XYO
01	Buzzer 5V	CM12P
01	1x5 AA Battery Holder	-
01	CI 78HC4051	SO16
14	Resistor 220Ω	SMD 1206
13	Resistor 10MΩ	SMD 1206
02	Pin Row MALE 1x40	-
02	Pin Row FEMALE 1x40	-
01	Pin Row FEMALE Angled 1x40	-
01	Sharp-SP2YOA21 IR Distance Sensor	-
01	PCB AETEL Helepolis Level 0	-
01	PCB AETEL Helepolis Level 1	-
01	PCB AETEL Helepolis Level 2	-
02	Pololu Geared Motor 1:100	-
02	Pololu Motor Bracket + 2xM2 10mm Screw + 2xM2 Nut	-
02	M3 5mm Screw	-
03	M3 10mm Screw	-
02	M3 15mm Screw	-
04	M3 40mm Screw	-
11	M3 Nut	-
09	M3 Washer	-
02	Screw Protector 12mm Black	-
04	Screw Protector 12mm Black	-
04	Screw Protector 15mm Black	-

Figure 1: Hardware Materials Table

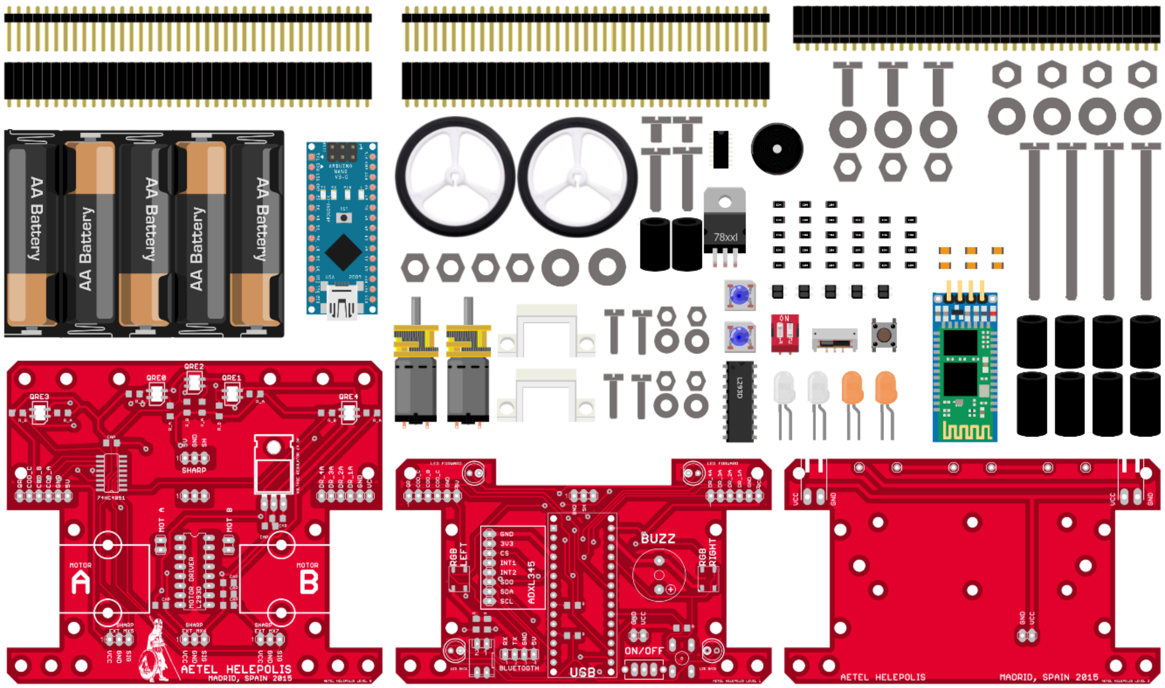


Figure 2: Hardware Materials

2.2. Tools

The tools needed to build an *AETEL Helepolis* are:

Q.	ITEM
1	Solder + Solder Tin
1	Desoldering tape
1	Standard Slotted Screwdriver
1	Precision Pliers
1	Thermic Fan (An average lighter could also be used)
1	Cutting Precision Blade

Figure 3: Tools Table

2.3. Assembly Guide

This section covers the differentiated assembly of the three PCBs separated in Level 0, Level 1 and Level 2.

For this section, in some cases a render image of the robot will be used instead of using real photographs. This will be done due to the better quality of the rendered images in documentation compared to real ones. This render can be opened with *Sketchup 2015*[5]. The file is for public domain in the *Sketchup Warehouse* under the name of "*AETEL Helepolis V1*"[6].

[5] Sketchup 2015(2015), Sketchup, http://www.sketchup.com/

[6] *AETEL Helepolis* 3D Model (11/02/2015), PablodMM, https://3dwarehouse.sketchup.com/model.html?id=u16a7b6ba-2d9a-4c1e-8311-0b5db75450b8

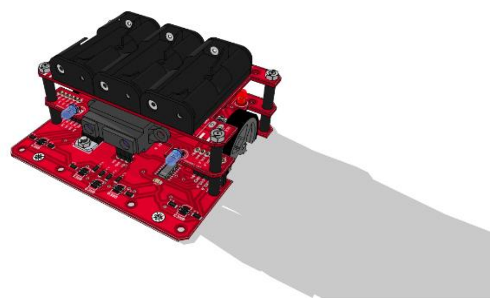


Figure 4: AETEL Helepolis Render Image

Figure 5: AETEL Helepolis Real Image

At the beginning of the guide, it is important to establish the two sides of the PCB as these terms will be used all through the document:

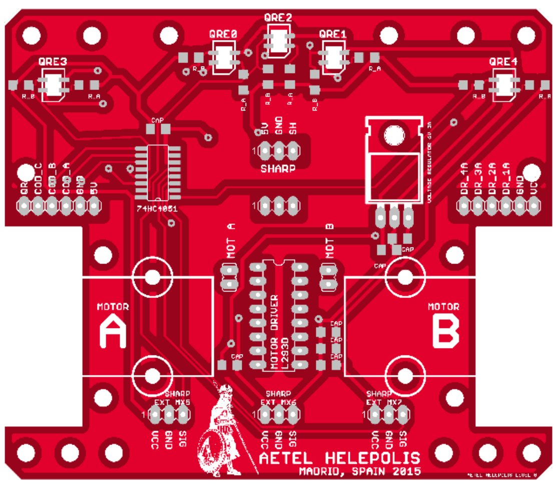


Figure 6: PCB TOP Layer

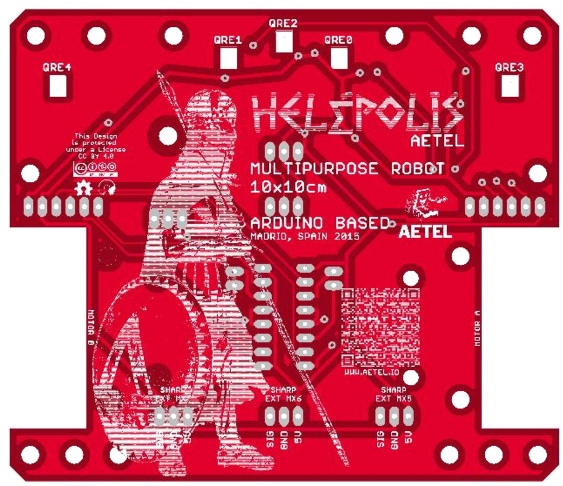


Figure 7: PCB BOTTOM Layer

2.3.1. Level 0 Assembly

This section contains the assembly guide of Layer 0 in step based instructions.

2.3.1.1. Step 1: SMD Multiplexor and Capacitor Soldering

The first step consists in the soldering of the SMD 74HC4051 and its capacitor. Normally SMD components are populated using semi-liquid solder paste and an electronic oven. As most people do not have one of these at home, the manual way is described.

To manually solder SMD by hand, first some solder tin has to be applied to one Pad, preferably in a corner. Then, the SMD IC has to be soldered in position and then, all the other pads have to be soldered. Make sure you orient the IC the right way, as marked in the silk of the PCB. Do not try to put the IC into place using your own hand as you may get hurt in a stupid and painful way.

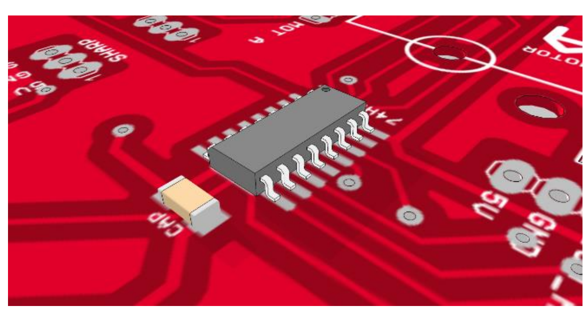


Figure 8: L0 74HC4051 Multiplexor Soldering

The capacitors have to be soldered repeating the same process, some solder tin has to be applied in one pad, one corner has to be soldered, the capacitor set in position and then the remaining pads soldered.

Once the IC 74HC4051 and the capacitor have been soldered, proceed to the next step.

2.3.1.2. Step 2: QRE1113 IR Sensor Circuit Soldering

The second step consists in the soldering of the resistor circuit for the QRE1113 IR sensors and the sensors themselves. The circuit for the QRE1113 consists in two resistors:

- The 220Ω resistors polarize the IR LED of the sensor.
- The 1MΩ resistors polarize the transistors of the sensor.

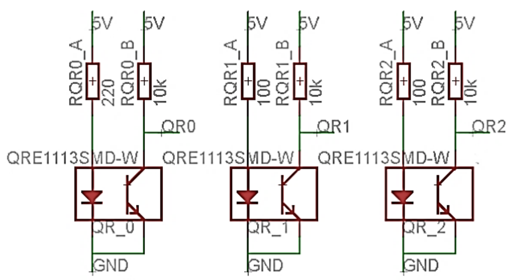


Figure 9: L0 QRE1113 IR Sensor Circuit

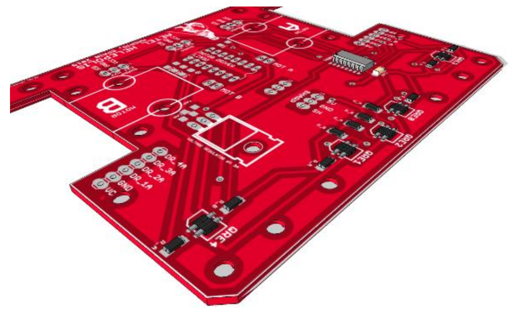


Figure 10: L0 QRE1113 Circuit Overview

In the serigraphy, LED resistors (220Ω) are marked as R_A and transistor resistors (1MΩ) as R_B. These resistors have to be soldered following the previous method described in *Level 0 Step 1* (2.3.1.1). Once these resistors have been soldered, proceed to solder the QRE1113. The QRE1113 are set to be soldered in the TOP layer to avoid any component to be on BOT layer exposed to contact with the surface in order to prevent these to get damaged when the *AETEL Helepolis* suffers crashes or any other sort of dramatic accidents.

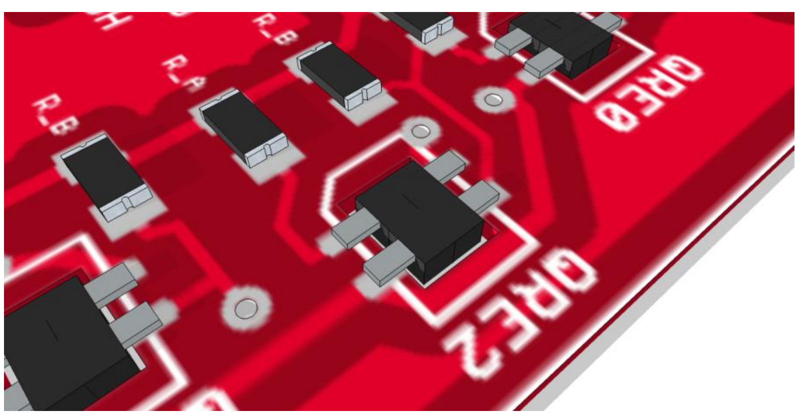


Figure 11: L0 QRE1113 Circuit Detail

The QRE1113 has to be soldered in the TOP layer upside down, so that the LED faces the ground. To correctly orient the IC Sensor, the segment corner has to be coherent with the serigraphy.

Once the 5 220Ω, the 5 1MΩ and the 5 QRE1113 IR sensors have been soldered, proceed to the next step.

2.3.1.3. Step 3: Motor Driver IC L293 Soldering

The third step consists in the soldering of the motor driver IC L293 and its capacitors. The capacitors work as decoupling ones to prevent distortions in the power line from affecting the IC performing.

First, the SMD capacitors have to be soldered. Then, the L293D IC has to be introduced from the TOP layer and every pin soldered in the BOT layer. The L293D does no use any kind of socket in order to use the PCB itself as a dissipater for the heat the driver produces.

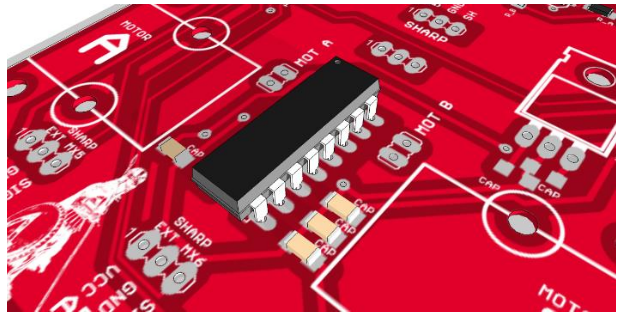


Figure 12: L0 L293D IC Circuit

Once the 4 capacitors and the L293D have been soldered, proceed to the next step.

2.3.1.4. Step 4: Voltage Regulator Circuit Soldering

The fourth step consists in the soldering of the regulation circuit. The circuit consists in a 6V 1.5A 7806 Voltage Regulator IC (Although a 5V Voltage Regulator could also be used) and two decoupling capacitors.

First, the two SMD capacitors have to be soldered. Then, introduce the 7806 bended in the TOP layer till the M3 10mm can be introduced from the BOT layer and the screw set. This way, the position of the IC is stable and it the IC soldered in the correct position. The 7806 IC is soldered with the screw for the PCB itself to act as a heat dissipater.

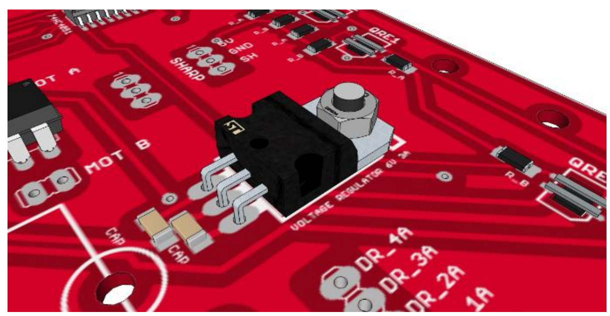


Figure 13: L0 Voltage Regulator Circuit

Once the 7806 IC and the 2 capacitors have been soldered, proceed to the next step.

2.3.1.5. Step 5: Extension Connector Soldering

The fifth step consists in the soldering of the extension connectors (intended to connect 3 more *Sharp-SP2YOA21 IR Distance Sensors* in order to measure distances in other directions (very useful for a *Maze Solver Robot* or to improve a *Sumobot*).

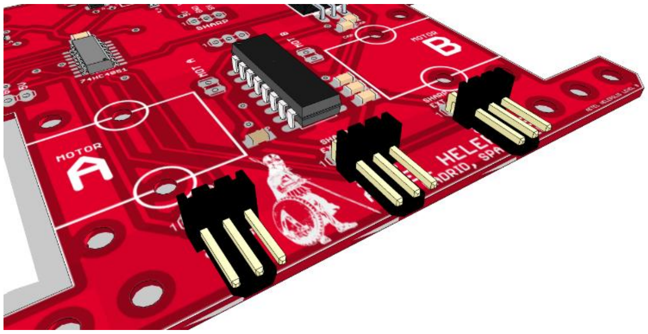


Figure 14: L0 Extension Connectors Soldering

To solder the 3 connectors, just introduce the form the TOP layer in its only position possible. Once the 3 connectors have been soldered, proceed to the next step.

2.3.1.6. Step 6: Level Connector Soldering

The sixth step consists in the soldering of the female pin connectors both to connect Level 0 to Level 1 and to connect the motors. The female pins have to be cut in two 1x6, one 1x3 and two 1x2 segments and soldered taking special care in keeping them straight.

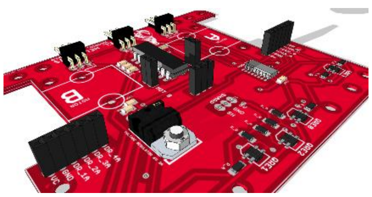


Figure 15: L0 Level Connectors Overview

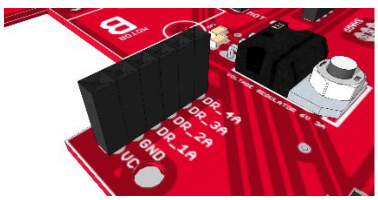


Figure 16: L0 Level Connectors Detail

Figure 17: L0 Motor Connectors

Once the 3 connectors have been soldered, proceed to the next step.

2.3.1.7. Step 7: IR Distance Sensor Pins Connector Soldering

The seventh step consists in the soldering of the connection pins for the *Sharp-SP2YOA21 IR Distance Sensor*. The male pin array has to be cut in one 1x3 and soldered, taking special care in keeping them straight.

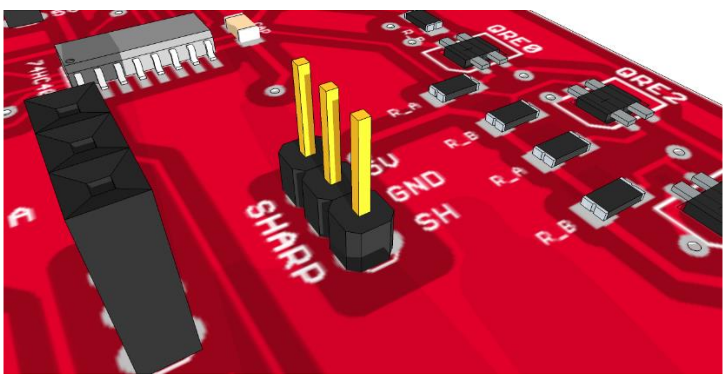


Figure 18: L0 SHARP Connection Pins

Once the connector has been soldered, proceed to the next step.

2.3.1.8. Step 8: IR Distance Sensor Connector Adaptation

The eight step consists in the adaptation of the regular connector of the *Sharp-SP2YOA21 IR Distance Sensor* to be connected through the SHARP connection pins. First, the standard connector has to be desoldered using the desoldering tape. Then, the female pin angled has to be cut to obtain a 1x3 segment. Finally, the female pin angled segment has to be soldered to the SHARP from the front.

Figure 19: SHARP Sensor Connector Adapter Front

Figure 20:SHARP Sensor Connector Adapter Back

Once the *SHARP-SP2YOA21 IR Distance Sensor* connection has been adapted, proceed to the next step.

2.3.1.9. Step 9: Motor Connector Soldering

The ninth step consists in the soldering of the wires for the *Pololu Geared Motor* connection. First, two wire pairs of 5cm aprox. have to be cut. Then, the male pin row has to be cut to obtain 2 1x2 segments.

The one end of each pair has to be soldered to the 1x2 pin segments. The other end has to be soldered to the motor terminals. To improve the final result and avoid any problems, the use of shrink tube is recommended to isolate the soldering.

Figure 21: L0 Pololu Geared Motor No Connection

Figure 22: L0 Pololu Geared Motor Connection

Once the *Pololu Geared Motor* Connections have been soldered, proceed to the next step.

2.3.1.10. Step 10: Motor and Wheel Colocation

The tenth step consists in the colocation of the *Pololu Geared Motors*. To do so, the brackets have to be set in position with the M2 Nut, M2 Washer and M2 10mm Screw with the motor placed so that only the gear stays outside the bracket, letting a minimum part of the motor step outside the PCB.

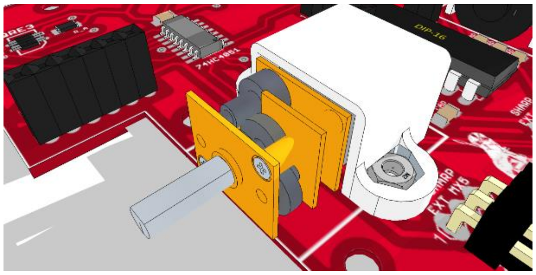


Figure 23: L0 Motor Bracket Colocation

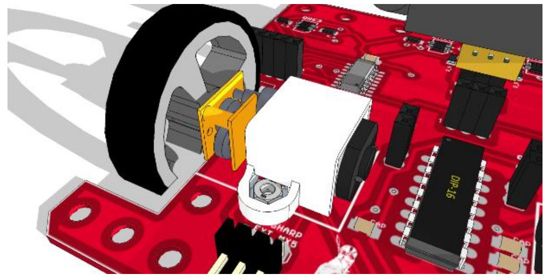


Figure 24: L0 Wheel Colocation

After setting the motors into position, introduce the *Pololu 7x32mm Wheel* in the motor axis.

Once the motors and wheels have been set into position, proceed to the next step.

2.3.1.11. Step 11: Front Separation Screw Colocation

The eleventh step consists in the colocation of the front floor separation screws. These Screws are optional and its objective is to create a distance between the edge of the PCBs and the floor to avoid small imperfections to change the direction of the robot. The M3 5mm Screws have to be introduced from the top side and secured with a M3 Nut.

Figure 25: L0 Front Separation Screw Up

Figure 26: L0 Front Separation Screw Down

Once the 2 M3 5mm Screws and the 2 M3 Nuts have been set into position, proceed to the next step.

2.3.1.12. Step 12: Back Separation Screw Colocation

The twelfth step consists in the colocation of the Back Screw Separation. This is optional but it prevents the *AETEL Helepolis* from performing unexpected back flips. The two M3 15mm Screws have to be introduced from the BOTTOM layer, then the two M3 10mm separation have to be introduced with two M3 Nuts.

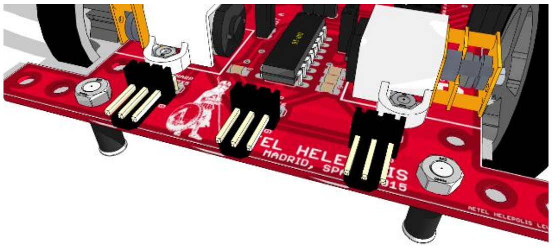


Figure 27: L0 Back Separation Screw Up

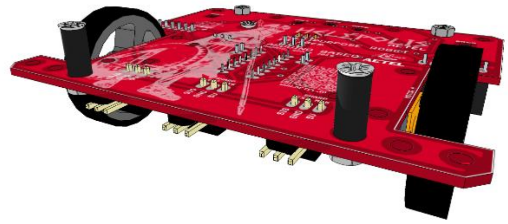


Figure 28: L0 Back Screw Separation Down

Once the motors and wheels have been set into position, the whole *AETEL Helepolis Level 0 PCB* is soldered and ready.

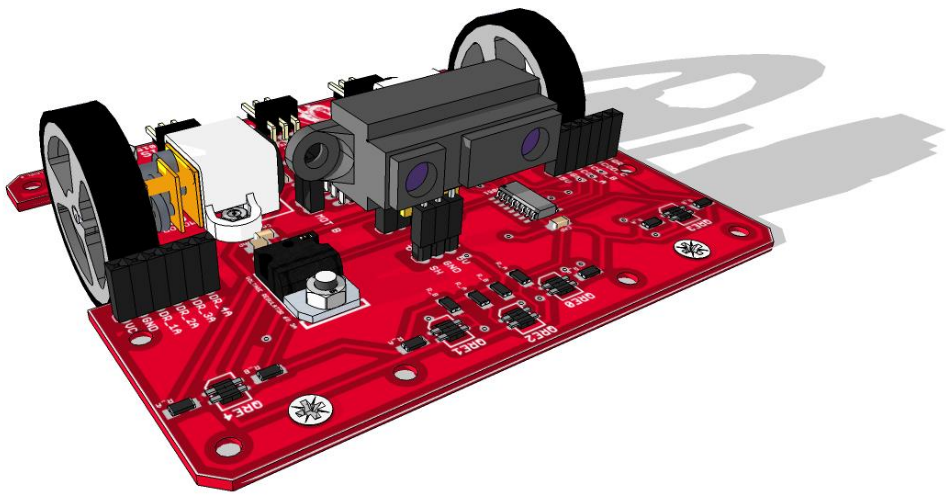


Figure 29: L0 Final Overview

2.3.2. Level 1 Assembly

This section contains the assembly guide of Layer 1 in step based instructions.

2.3.2.1. Step 1: Status SMD LED Soldering

The first step consists in the soldering of the SMD LED WS2812B. These RGB LEDs are intended for monitoring the states of the *AETEL Helepolis* or to differentiate a specific robot among a horde of similar ones. The LEDs have to be soldered on the TOP layer with the manual SMD soldering techniques applied previously. Special care has to be taken to correctly orient the LED according to the silk mark. Otherwise, a shortcut is created and the robot will have supply problems.

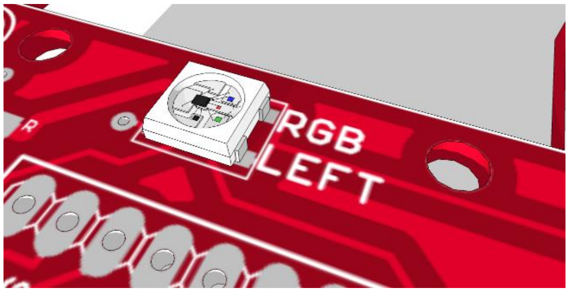


Figure 30: L1 LD SMD Overview

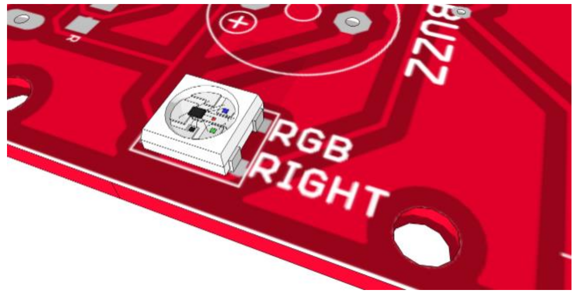


Figure 31: L1 LED SMD Orientation

Once the 2 WS2812B LEDs have been soldered, proceed to the next step.

2.3.2.2. Step 2: Front and Back LEDs Circuit Soldering

The second step consists in the soldering of the front and back LEDs circuit soldering. The Front and Back LEDs are controlled in pair through 2 *Arduino* pins and, therefore, they cannot be turned on and off independently. First solder the two 220Ω SMD Resistors in the pads located inside the *Arduino* region. Then the back LEDs (Red or Orange) have to be soldered inserting them from the TOP layer and leaving no space between the PCB and the LED. Finally, the front LEDs have to be bended before soldering, for them to act as a flashlight for the *AETEL Helepolis*. Make sure the bending is done well before soldering. The front LEDs have to be soldered introducing them form the TOP layer. The remaining parts of the LEDs have to be utterly cut.

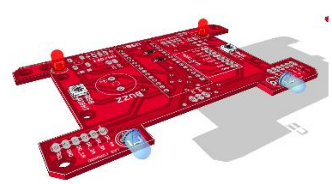


Figure 32: L1 Front and Back LEDs Overview

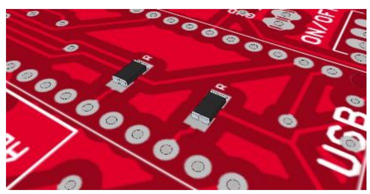


Figure 33: L1 LED Resistor Detail

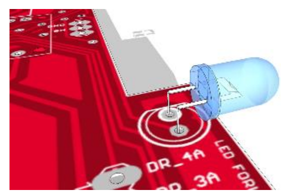


Figure 34: L1 Front LED Detail

Once the 2 SMD resistors, the 2 Red or Orange LEDs and the 2 White LEDs have been soldered, proceed to the next step.

2.3.2.3. Step 3: Tactile Switch Circuit Soldering

The third step consists in the soldering of the tactile switch soldering. This switch is used to trigger different behaviour in some modes (such as the start of the *Sumobot* combat mode) the use of this tactile switch in the different proposed modes will be described in detail in the Usage Guide section.

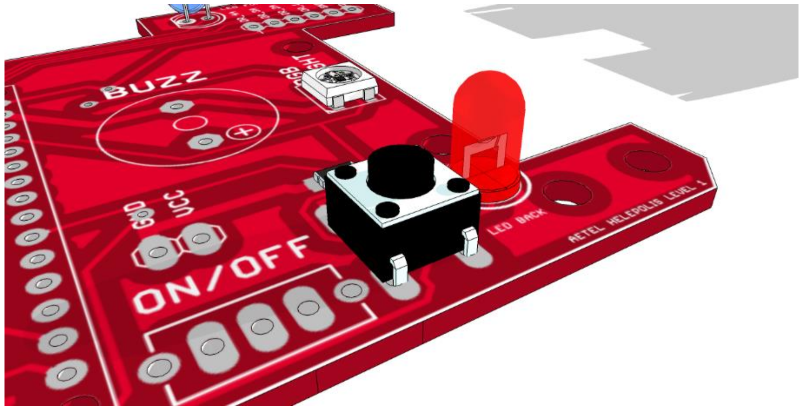


Figure 35: L1 Tactile Switch Circuit

Firstly, the 10MΩ SMD resistor has to be soldered. Secondly, the Tactile Switch has to be introduced from the TOP layer and soldered.

Once the SMD resistor and the Tactile Switch have been soldered, proceed to the next step.

2.3.2.4. Step 4: Mode Switch Circuit Soldering

The fourth step consists in the soldering of the Mode Switch circuit. The Mode Switch is used to set the mode in which the *AETEL Helepolis* has to work during the Reset of the robot, allowing a total of 4 modes to be programmed at the same time. First, the two 10MΩ SMD resistors have to be soldered. Then, the 1x2 Microswitch has to be soldered.

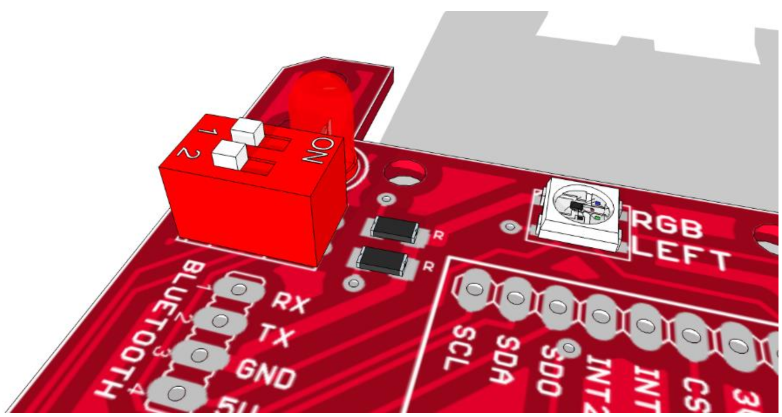


Figure 36: Mode Switch Circuit

Once the 2 SMD resistors and the 1x2 Microswitch have been soldered, proceed to the next step.

2.3.2.5. Step 5: Bluetooth Connector Soldering

The fifth step consists in the soldering of the connector for the Bluetooth module. First, the female pin angled row has to be cut to obtain a 1x4 segment. The 1x4 segment has to be soldered introducing them from the TOP layer.

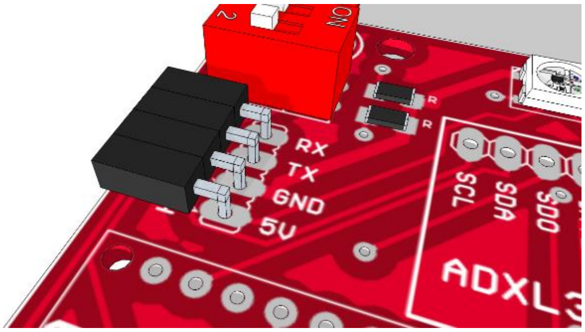


Figure 37: L1 Bluetooth Connector

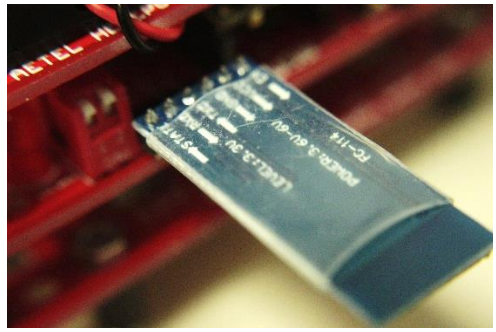


Figure 38: L1 Bluetooth Module Connected

Once the 1x4 female pin angled segment has been soldered, proceed to the next step.

2.3.2.6. Step 6: Buzzer Soldering

The sixth step consists in the soldering of the buzzer. The 5V buzzer has the duty of playing beautiful melody to celebrate your victories or sad, dramatic requiems for your most humiliating defeats. The buzzer has to be introduced from the TOP Layer and soldered.

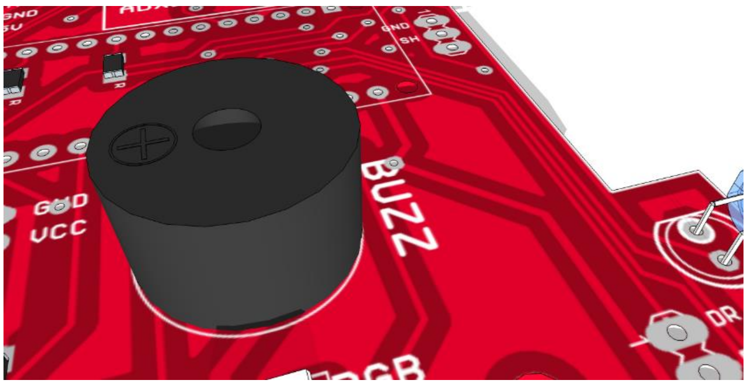


Figure 39: L1 Buzzer

Once the buzzer has been soldered, proceed to the next step.

2.3.2.7. Step 7: Power Switch Soldering

The seventh step consists in the soldering of the power switch of the *AETEL Helepolis*. This switch controls the general ON/OFF shut. It has to be introduced from the TOP layer and soldered.

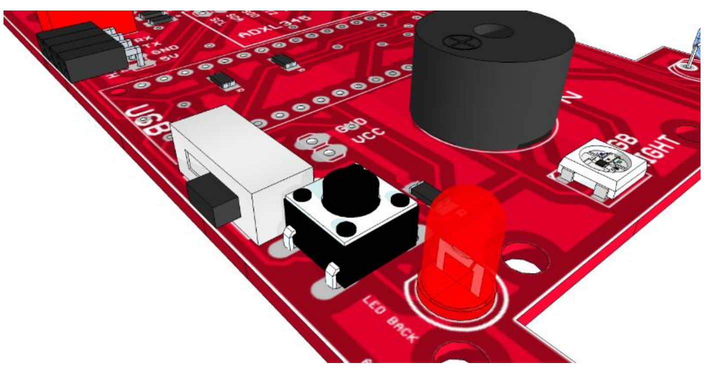


Figure 40: L1 Power Switch

Once power switch has been soldered, proceed to the next step.

2.3.2.8. Step 8: Arduino Pin Socket Connector Soldering

The eighth step consists in the soldering of the *Arduino Pin Socket*. The female pin row has to be cut intro two 1x15 segments. The female pin segments have to be introduced from the TOP layer and soldered. The *Arduino* can be introduced now or once the whole robot has been soldered.

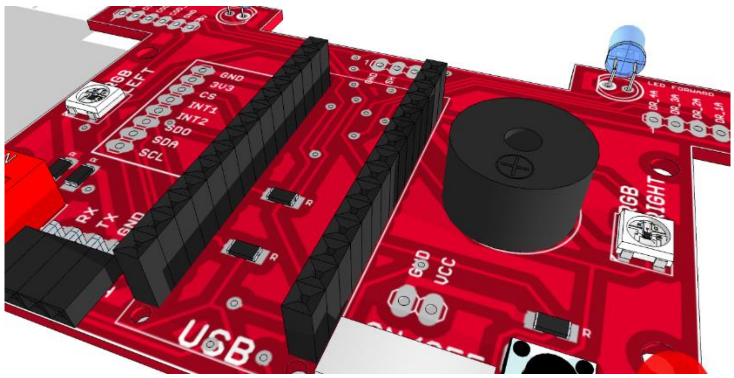


Figure 41: L1 Arduino Socket

Once the two 1x15 female pin segments are soldered, proceed to the next step.

2.3.2.9. Step 9: Accelerometer Soldering

The ninth step consists in the soldering of the ADXL345 Accelerometer. This Accelerometer is, at the time this document has been released, not yet supported by the software. The accelerometer has to be soldered introducing it form the TOP layer and soldered.

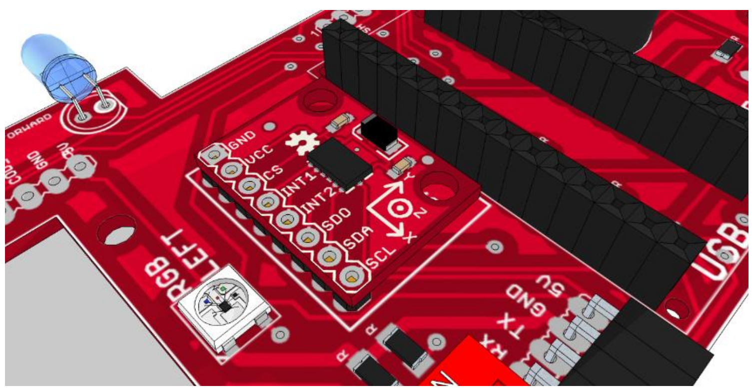


Figure 42: L1 ADXL345 Accelerometer

Once the ADXL345 Accelerometer has been soldered, proceed to the next step.

2.3.2.10. Step 10: Level 0 Connection Soldering

The tenth step consists in the soldering of the connection between Level 0 and Level 1. This is done through male pins that will connect with the female pins of Level 0. First, the male pin row has to be cut into two 1x6 and one 1x3 segments. Then, introduce the short part of the pin segments from the BOTTOM layer and solder.

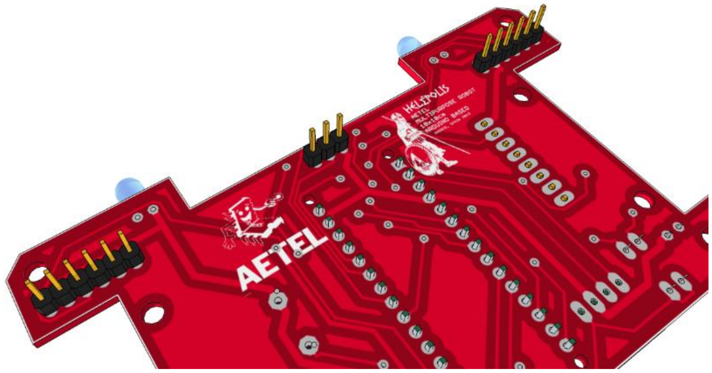


Figure 43: L1 Level 0 Connection

Once the two 1x6 and the 1x3 male pin segment are soldered, proceed to the next step.

2.3.2.11. Step 11: Level 2 Connection Soldering

The eleventh step consists in the soldering of the connection between the Level 1 and Level 2. This power (VIN, GND) connection is done through two pins. The female pin row has to be cut into one 1x2 segment and soldered.

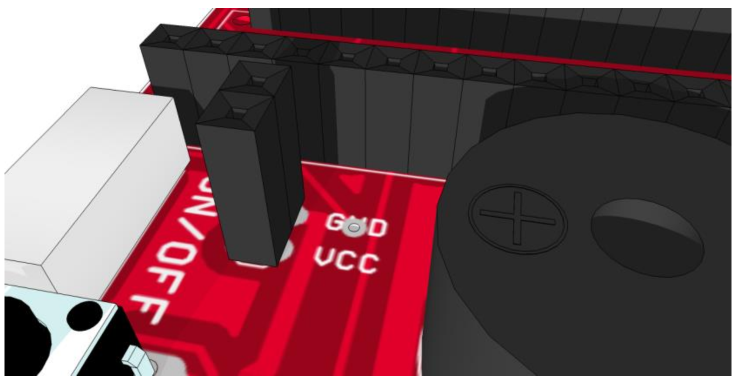


Figure 44: L1 Level 2 Connection

Once the 1x2 female pin segment has been soldered, the whole *AETEL Helepolis Level 1 PCB* is soldered and ready.

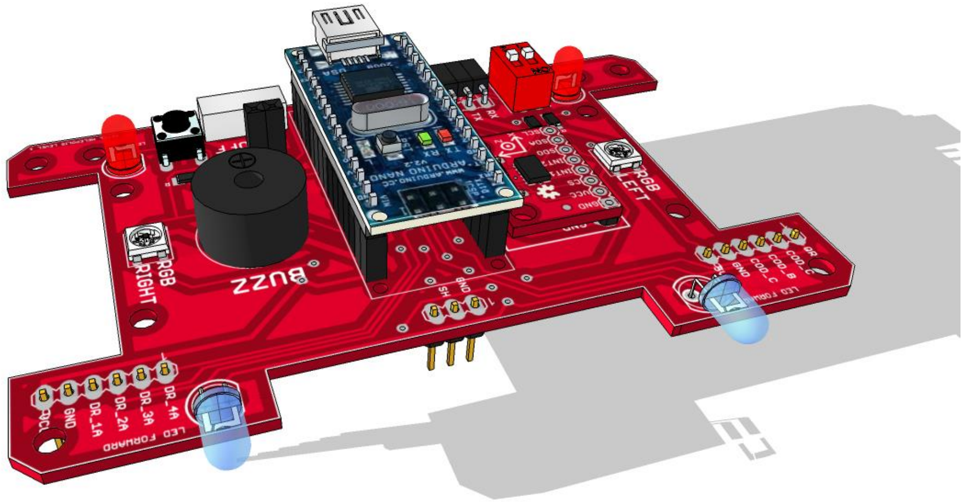


Figure 45: L1 Final Overview

2.3.3. Level 2 Assembly

This section contains the assembly guide of Layer 2 in step based instructions.

2.3.3.1. Step 1: Level 1 Connection Soldering

The first step consists in the soldering of the connection between the Level 1 and Level 2. This power (VIN, GND) connection is done through two pins. The female pin row has to be cut i nto one 1x2 segment, introduced from the BOT layer and soldered. Then two pins or scrap wires have to be introduced inside the 1x2 female pin segment to create a false high male pin segment.

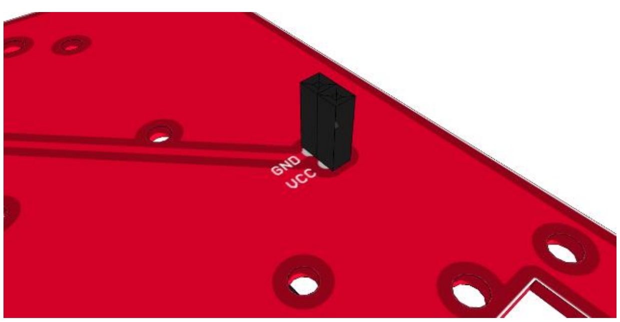


Figure 46: L2 Level 1 Connection

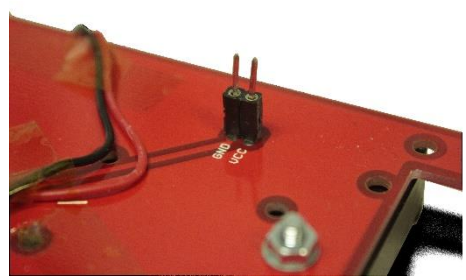


Figure 47: L2 Level 1 Connection Pins

Once the 1x2 female pin segment has been soldered, proceed to the next step.

2.3.3.2. Step 2: Battery Holder Colocation and soldering.

The second step consists in the colocation of the 5xAAA Battery holder in the *AETEL Helepolis* PCB Level 2. To do so, the battery holder has to be set into position so that it can be screwed to the PCB using the M3 10mm Screw, Nut and Washer. Once the battery holder is set into position, the wires of the battery holder have to be soldered to the PCB power pads.

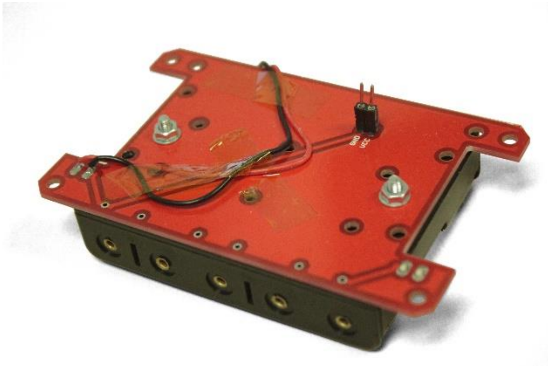


Figure 48: L2 Battery Holder Down

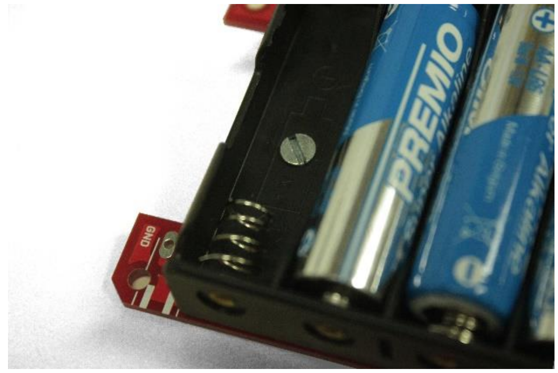


Figure 49: L2 Battery Holder Up

The *AETEL Helepolis* has been designed to allow some modifications in structure and electronics. The powering of the robot can be done through 5xAAA batteries or 6xAA batteri es, both using the same space present in the *AETEL Helepolis* PCB Level 2.

Once the 5xAAA Battery holder is set in position and the wires correctly soldered, the whole *AETEL Helepolis Level 1 PCB* is soldered and ready.

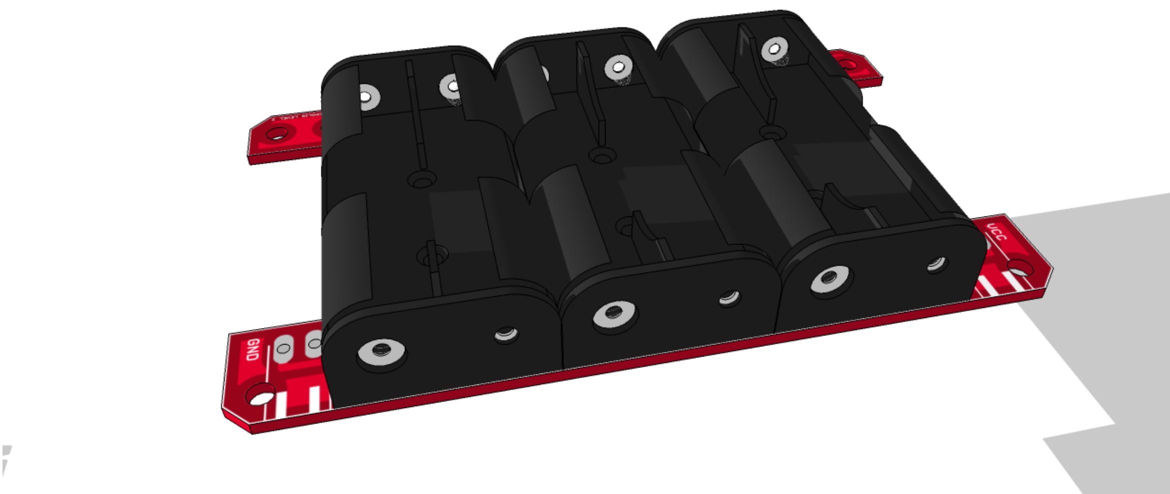


Figure 50: L2 Final Overview

2.3.4. Robot Assembly

This section contains the general assembly guide of the *AETEL Helepolis* in step based instructions.

2.3.4.1. Step 1: Layer Connection

The first step consists in the connection of the three *AETEL Helepolis* layer PCB. Build the *AETEL Helepolis* by connecting the different already soldered PCB Layers. The robot should not be exposed to great mechanical forces to avoid the breaking of pins.

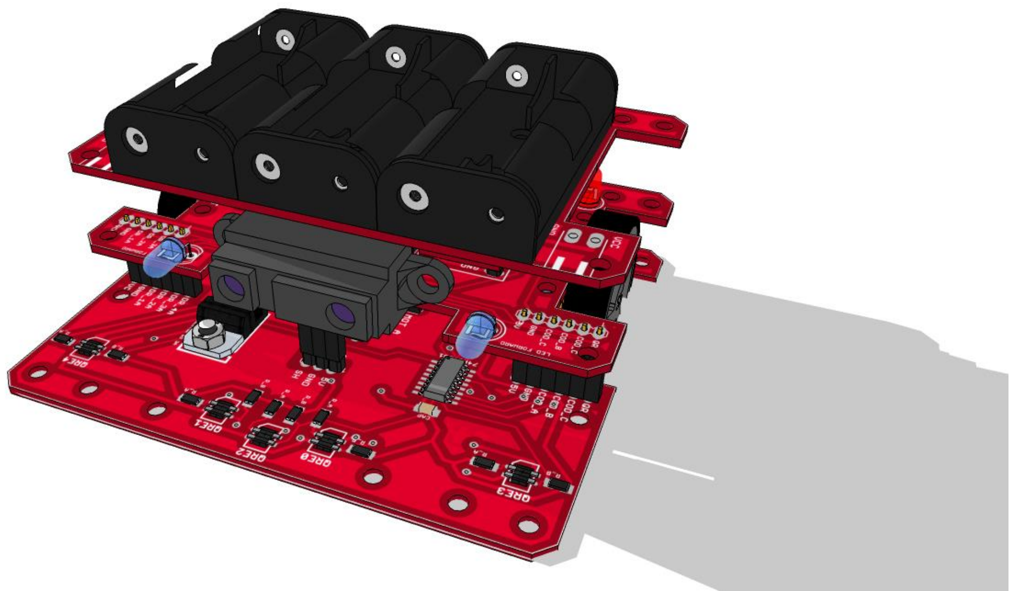


Figure 51: Robot Assembly No Screws Overview

Once the three layers have been attached, proceed to the next step.

2.3.4.2. Step 2: Screw Colocation

The second step consists in the screw colocation. The screws are what fit the whole *AETEL Helepolis* together. Insert the M3 40mm Screws from the BOT layer of level 0, insert the M3 12mm Screw Protectors between Level 0 and Level 1 and the M3 15mm Screw Protectors among Level 1 and Level 2. Finally, attach then M3 nuts and M3 washers.

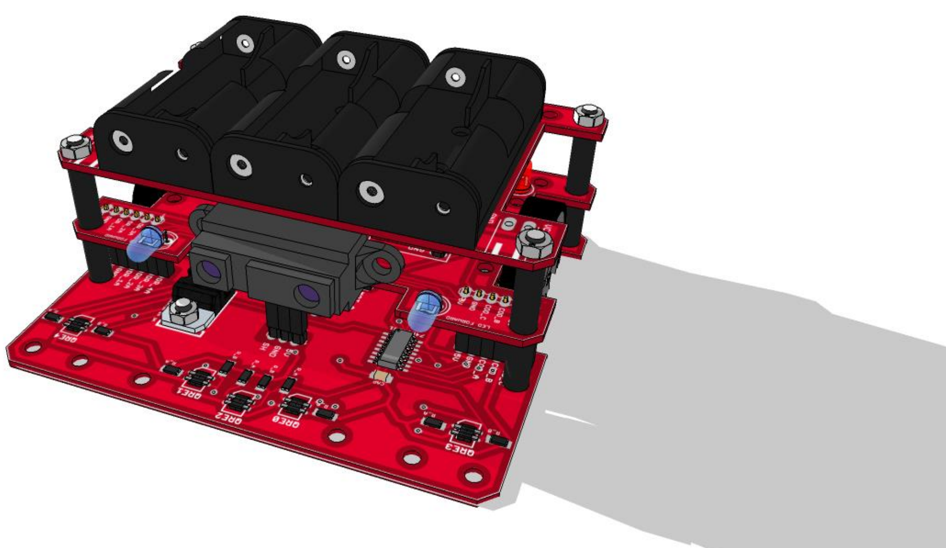


Figure 52: Robots Assembly Complete Overview

Once the four M3 40mm Screws, M3 Nuts, M3 washers, M3 12mm Screw Protectors and M3 15mm Screw Protectors have been collocated, the whole assembly of the *AETEL Helepolis* is completed.

3. Software Guide

This section contains a guide into the software set up of the *AETEL Helepolis*. In this guide, only Windows OS and Android are considered. Anyway, the processes are simple and the programs are all available in Linux and Mac IOS (Except the *AETEL Helepolis* Bluetooth App).

3.1. Software Needed

The software needed to program the *AETEL Helepolis* is:

***Arduino* IDE + *Arduino* Drivers (1.6.4 or previous)**[7] Free Download in: http://www.*Arduino*.cc/en/Main/Software	
***Arduino* Adafruit_Neopixel library**[8] Download in: https://github.com/adafruit/Adafruit_NeoPixel	
AETEL Helepolis App Download in: https://github.com/Javierma/Helepolis	

3.2. Arduino IDE and libraries installation

This section contains the link to the *Arduino Website* sections in which different processes are described:

Getting Started with Arduino[9]
Described here:
https://www.arduino.cc/en/Guide/HomePage

3.3. Arduino Program

The following *Arduino* program can be found at *GitHub* under the *Arduino Files* folder. It is self-explanatory through the commentaries. To properly program an *Arduino Nano,* please refer to the manual present in the *Arduino Website*.

4. User Guide

This section contains a user guide into the different modes present in the Arduino program.

4.1. Turning on the *AETEL Helepolis*

The first thing to do is to put the 5 AA or 6 AAA Batteries into the Battery Holder. Then, put the switch ON.

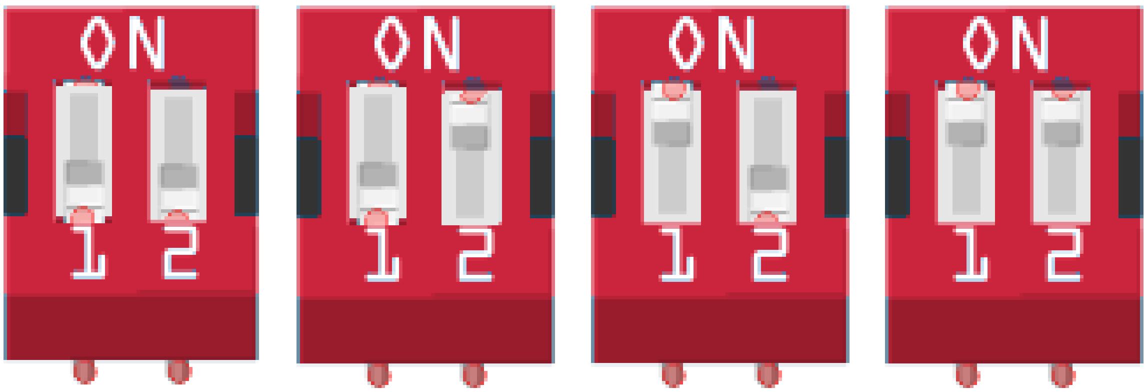
---

[7] *Arduino* IDE 1.6.4. Download (nd), *Arduino*, http://www.*Arduino*.cc/en/Main/Software
[8] *Arduino* Neopixel Library (2014), *Adafruit, https://github.com/adafruit/Adafruit_Neopixel*
[9] Getting started with Arduino (nd), Arduino, https://www.arduino.cc/en/Guide/HomePage

4.2. Function Modes

This section describes the different modes of the official *AETEL Helepolis*. However, as it is an Open Source project, it is intended that the users destroy, improve and modify the original program.

The functioning mode is determined during the reset through the *1x2 Microswitch*, being the different combinations:



Sumobot Mode WL **Sumobot Mode BL** **Line Follower Mode** **Bluetooth Mode**

Figure 53: Mode Switch Configuration

4.2.1. Sumobot Mode WL (White Border)

The Sumobot Mode programs the *AETEL Helepolis* to act as a Sumobot. The aim is to Search&Destroy a rival. Both Sumobots are inside a Dojo. The Dojo has a black surface with white border, which objective is for the Sumobot to detect the border through the IR Sensors, avoiding the robot getting out of the Dojo.

The normal work of the Sumobot consists in searching for the rival Sumobot rolling. Once the opponent is detected, the robot advances towards it and tries to push it out the Dojo, without falling himself (through the border detection).

To set up the Sumobot, turn on the *AETEL Helepolis* with the proper configuration and collocate it in the correct place. Once the referee marks the start of the combat, press the tactile switch to initiate the 5 Sec countdown. Once the countdown is over, the Sumobot will start its mortal behaviour.

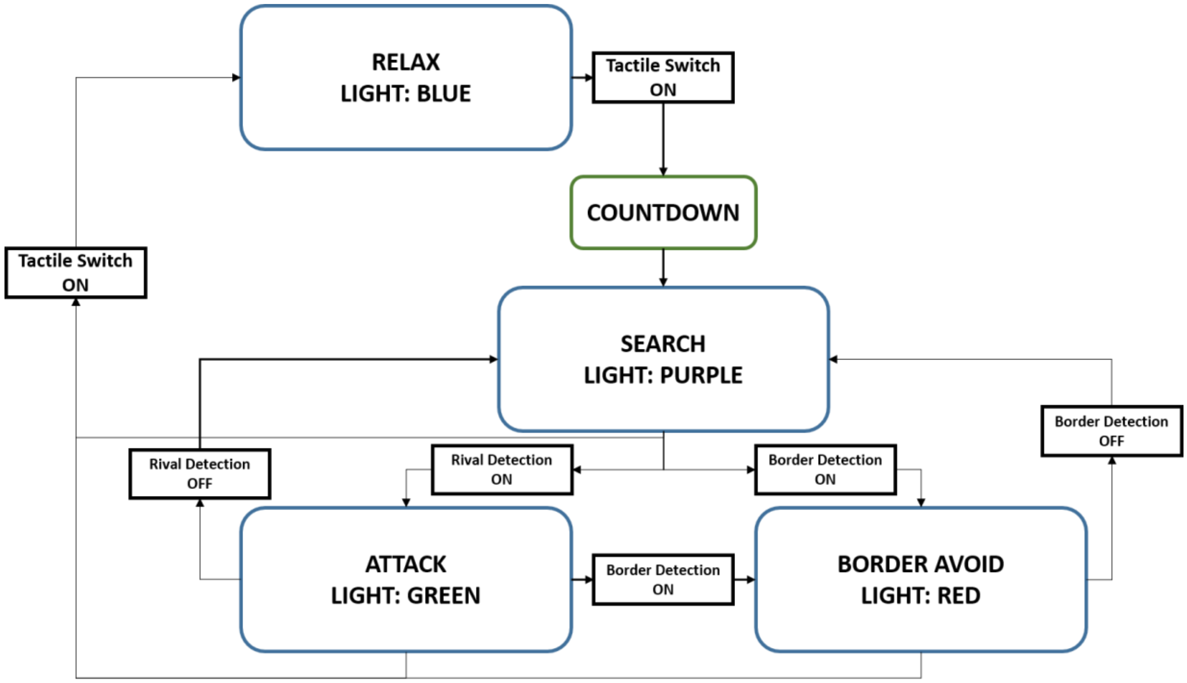
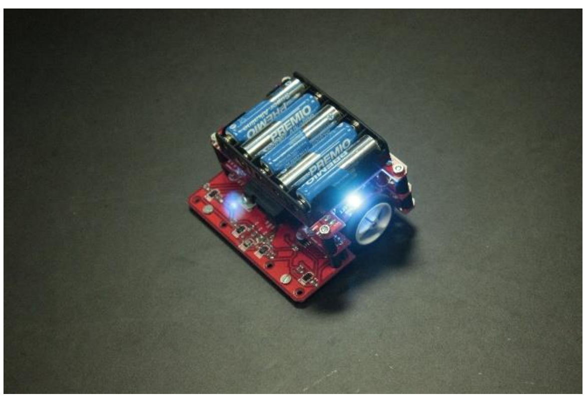


Figure 54: Sumobot Mode Block Diagram

4.2.1.1. Relax State

The *AETEL Helepolis* is stopped and waiting for the tactile switch to be pushed. The RGB LEDs light blue.



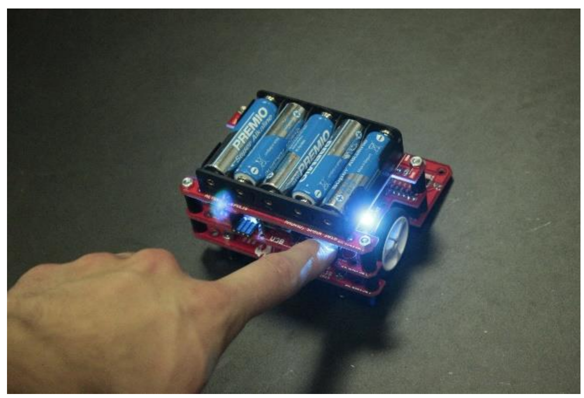


Figure 55: SM Mode Relax State

4.2.1.2. Countdown Transition

The *AETEL Helepolis* waits for 5 seconds. The RGB LEDs switch intermittent light white and buzzer tweets.

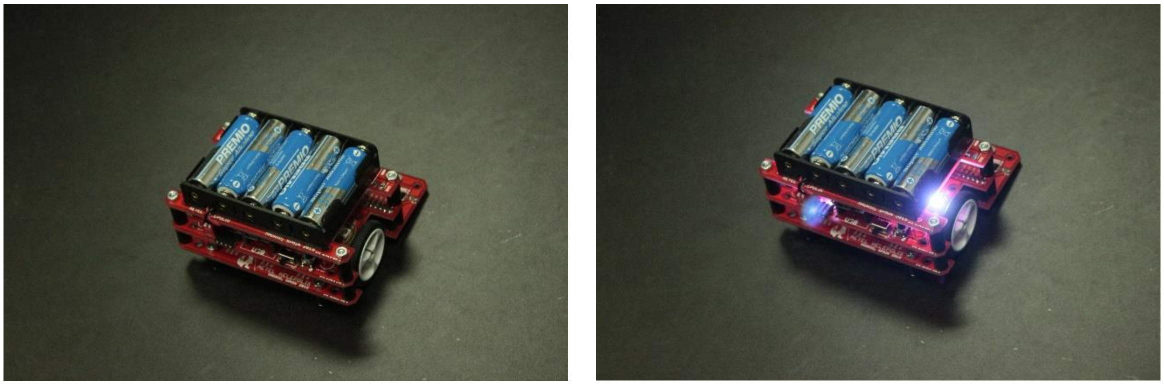


Figure 56: SB Mode Countdown

Once the Countdown is over, it switches to SEARCH RIVAL State.

4.2.1.3. Search Rival State

The *AETEL Helepolis* turns around, searching a rival through the IR Distance Sensor. The RGB LEDs light purple.

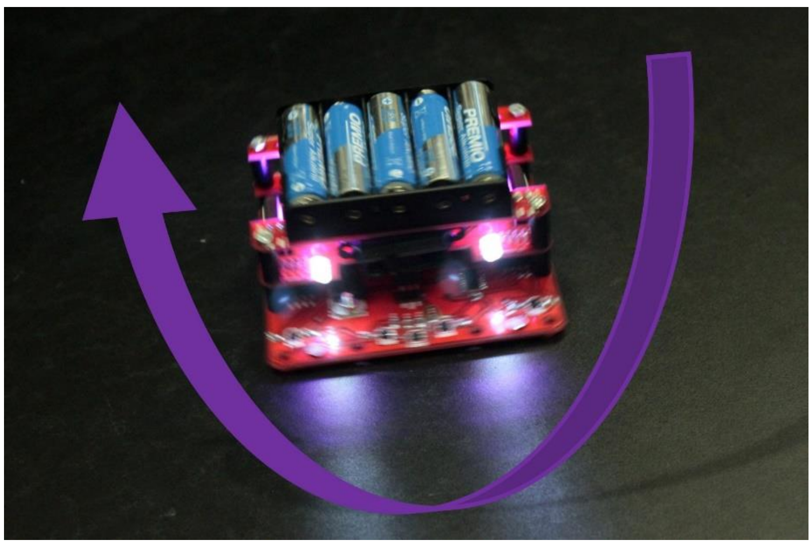


Figure 57: SM Mode Search Rival State

If a rival is detected, it switches to PUSH FORWARD State.

If the border is detected, it switches to RETREAT State.

4.2.1.4. Attack State

The *AETEL Helepolis* advances to push the rival. The RGB LEDs light green.

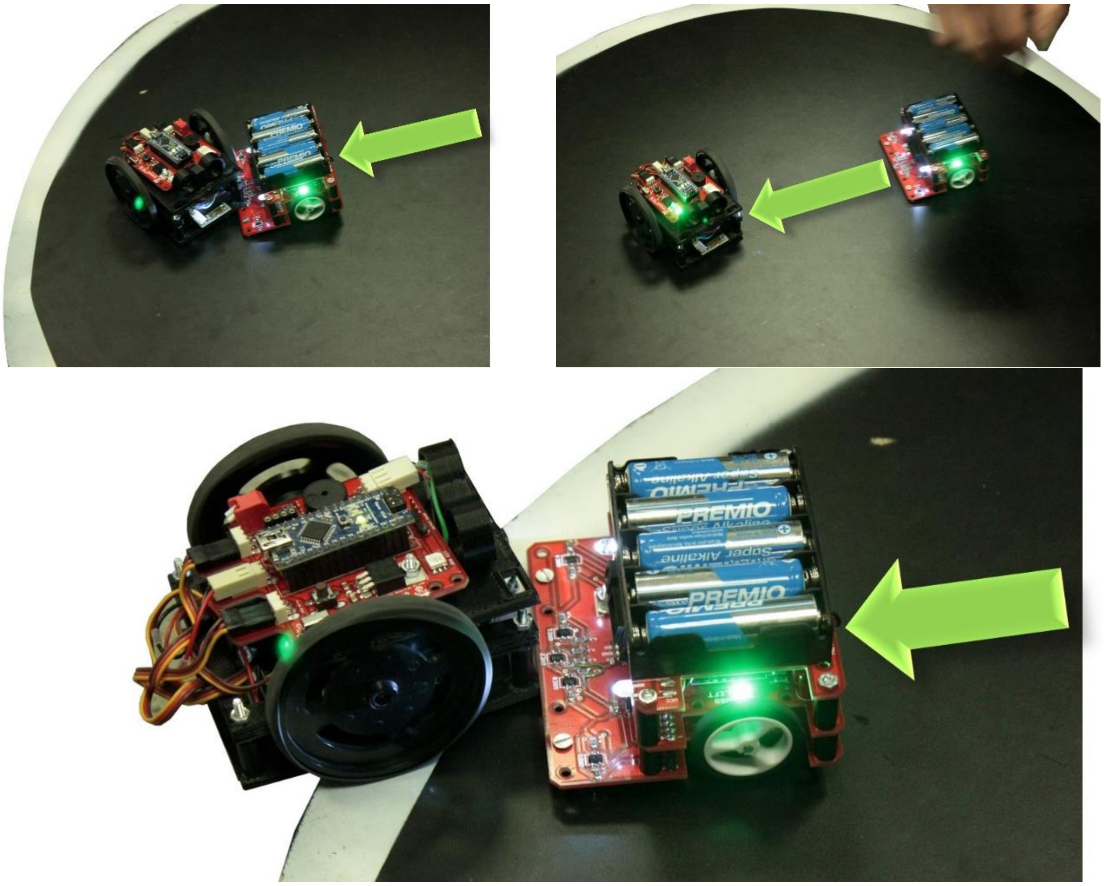


Figure 58: SB Mode Attack State

If the border is detected, it switches to RETREAT State.

If it loses detection of the rival, it switches to SEARCH RIVAL State.

4.2.1.5. Border Avoid State

The *AETEL Helepolis* moves back to avoid falling from the *Dojo*. The RGB LEDs light red.

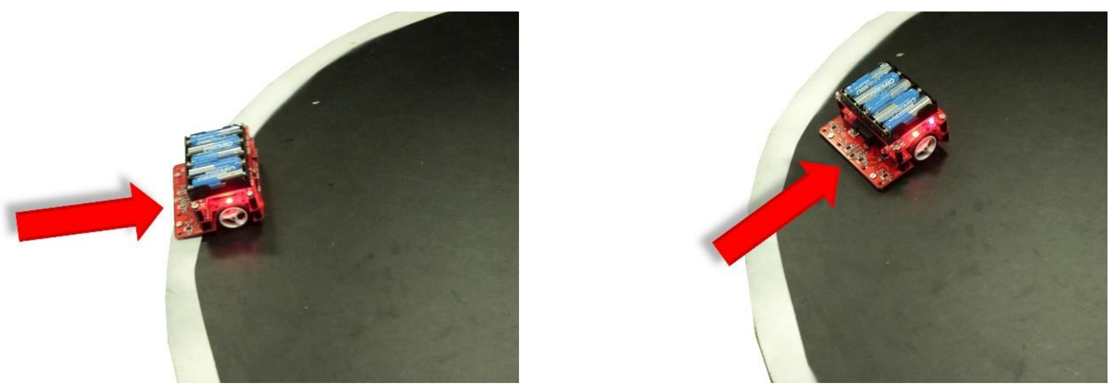


Figure 59: SM Mode Border Avoid State

If it does not detect the border any longer, it switches to SEARCH State.

4.2.2. Sumobot Mode BL (Black Border)

This mode is similar to the *Sumobot Mode WL* (Described in *4.2.1*) but detecting black borders instead of white borders.

4.2.3. Line Follower

The *Line Follower Mode* programs the robot to behave as a white line follower. Its aim is to follow a white line detecting it through the IR Sensor array. To make it work, first set the *AETEL Helepolis* over or next to a white line, then press the Button to activate.

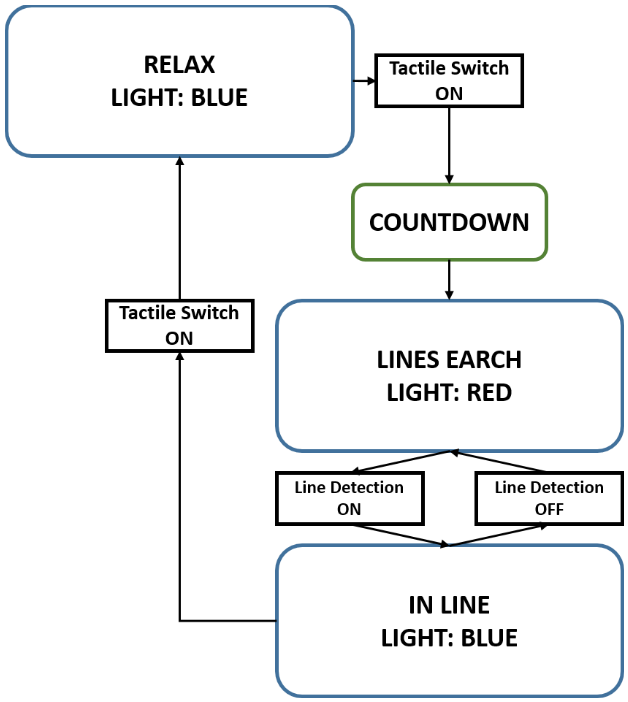


Figure 60: Line Follower Mode Block Diagram

4.2.3.1. Relax State

The *AETEL Helepolis* is stopped and waiting for the tactile switch to be pushed. The RGB LEDs light blue.

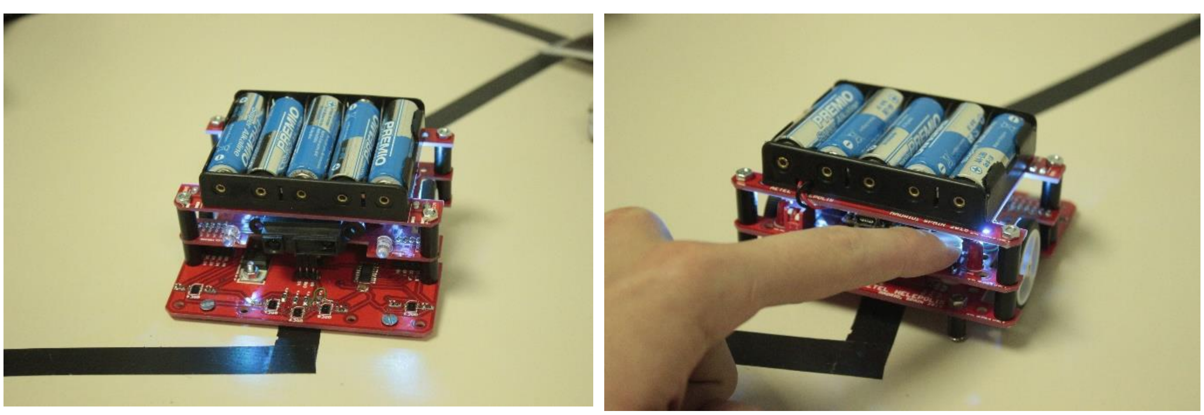


Figure 61: LF Mode Relax State

4.2.3.2. Countdown Transition

The *AETEL Helepolis* waits for 5 seconds. The RGB LEDs switch intermittent light white and buzzer tweets.

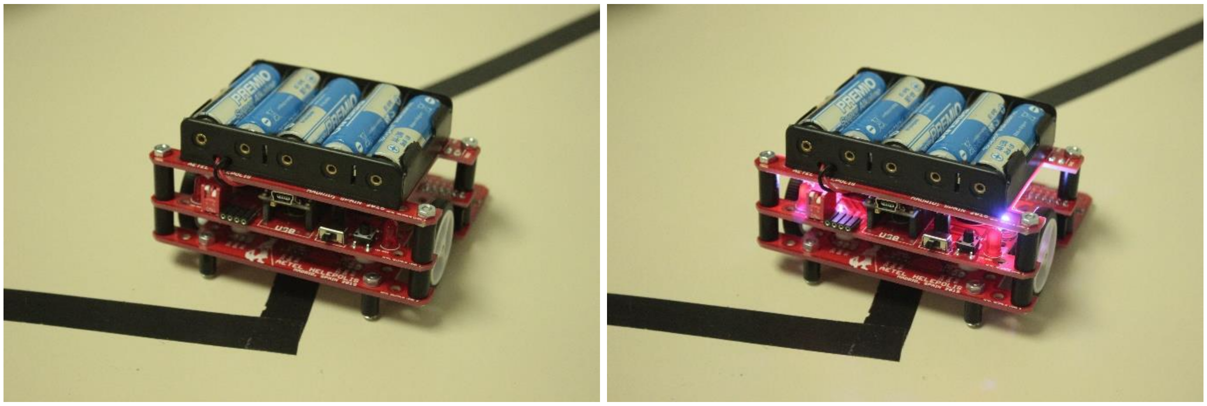


Figure 62: LF Mode Countdown

Once the Countdown is over, it switches to LINE SEARCH State.

4.2.3.3. Line Search State

The *AETEL Helepolis* turns around searching the line through the IR Distance Sensor. The RGB LEDs light red.

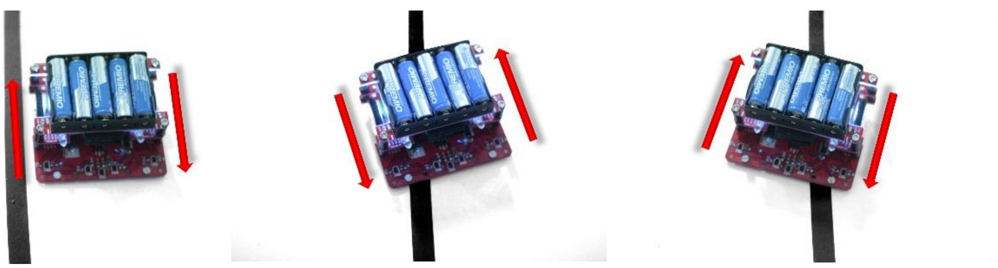


Figure 63: LF Mode Line Search State

If the line is detected, it switches to IN LINE State.

If the Switch is pushed, it switches to RELAX STATE.

4.2.3.4. In Line State

The *AETEL Helepolis* follows the line. The RGB LEDs light blue.

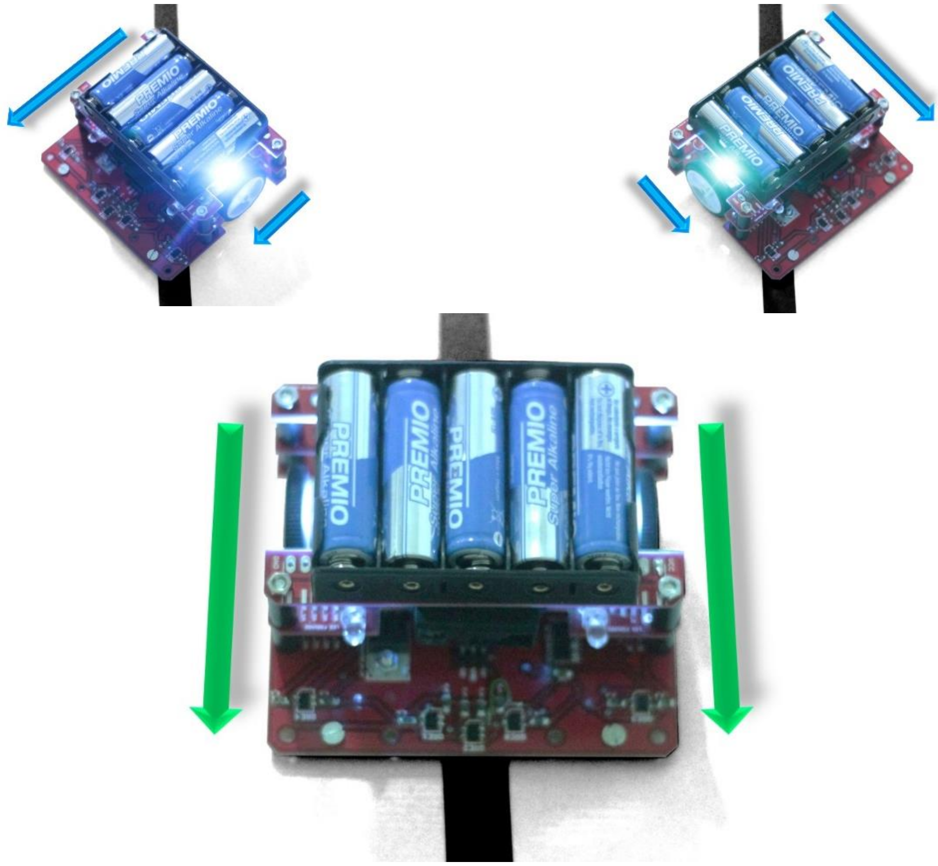


Figure 64: LF Mode in Line Mode

If the line is no longer detected, it switches to LINE SEARCH State.

If the Switch is pushed, it switches to RELAX State.

4.2.4. Bluetooth Controlled State

The *Bluetooth Mode* programs the robot to behave as a Bluetooth remote controlled device. This way, it is possible to remotely control the robot through an Android application running on Android 4.0.3 or upper version.

4.2.4.1 Screen views and control

4.2.4.1.1 Application start

To start the application, click on AETEL Helepolis icon.

Click here to
start application

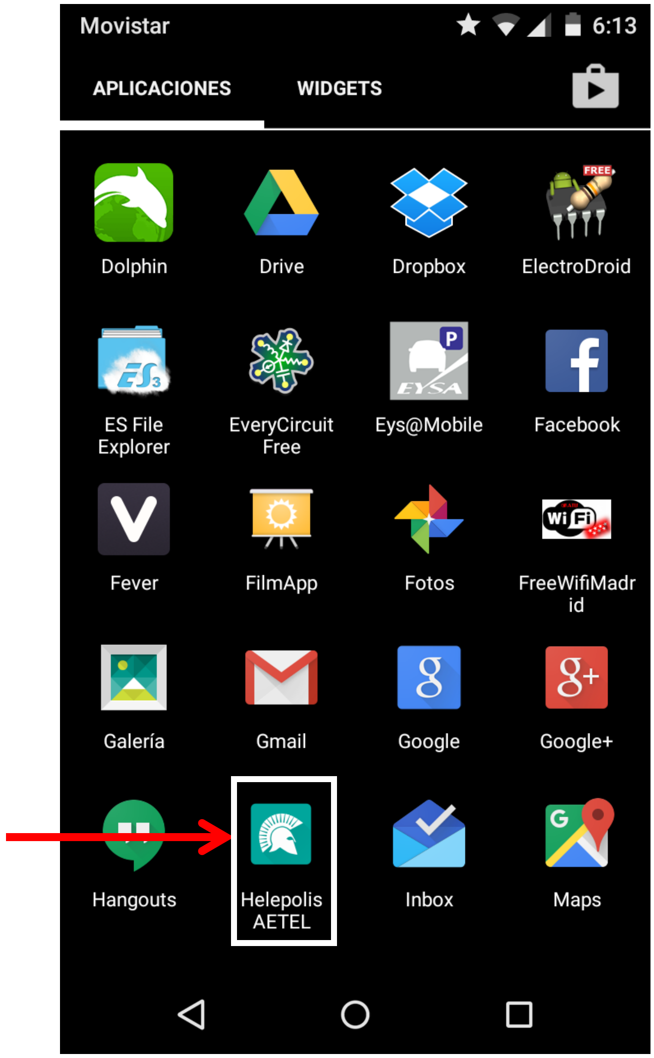


Figure 65: Application start

4.2.4.1.2 Main view

In this screen, it is possible to select the mode to be used, which are *'Serial killer mode'* and *'Coward mode'*. The difference is that coward mode disallows crashing with a wall or anything else, so in case of using the application for the first time, getting confidence controlling the robot or just for being a coward, it can be a good alternative to avoid problems and/or repairs.

Help button shows the user how the robot is controlled for the different available movements.

In case of pressing 'Continue' button, the view will disappear to continue with the setup process.

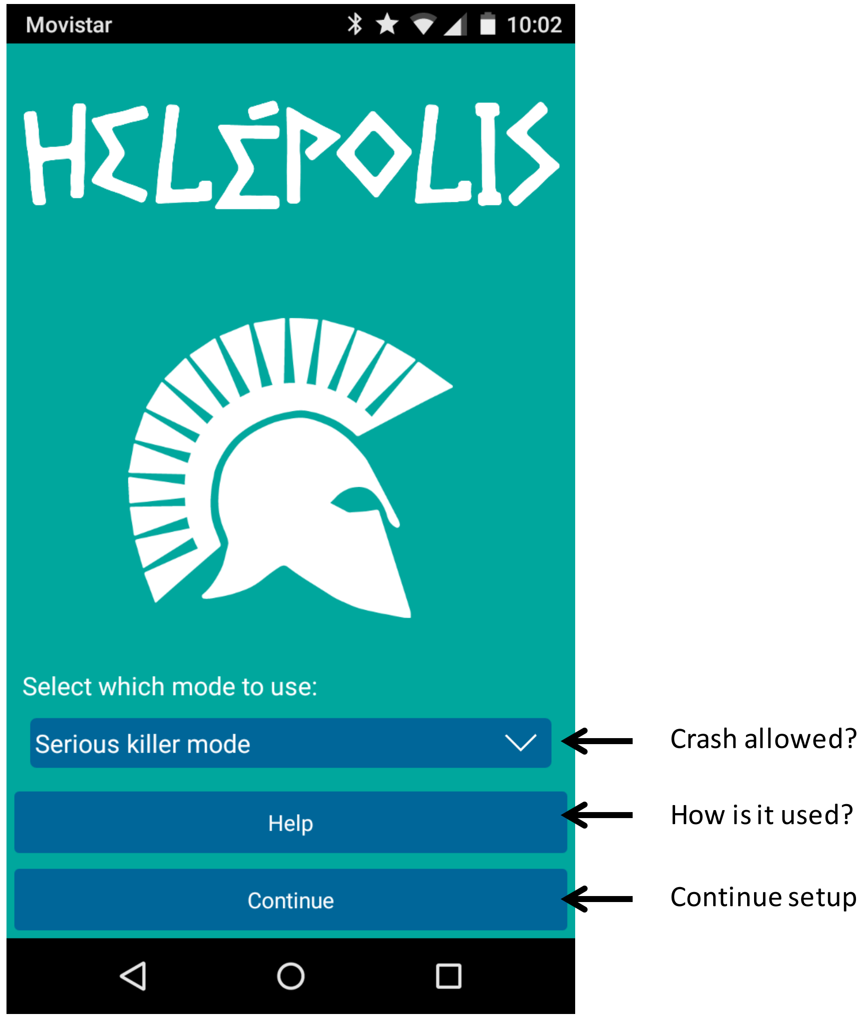


Figure 66: Main Application screen

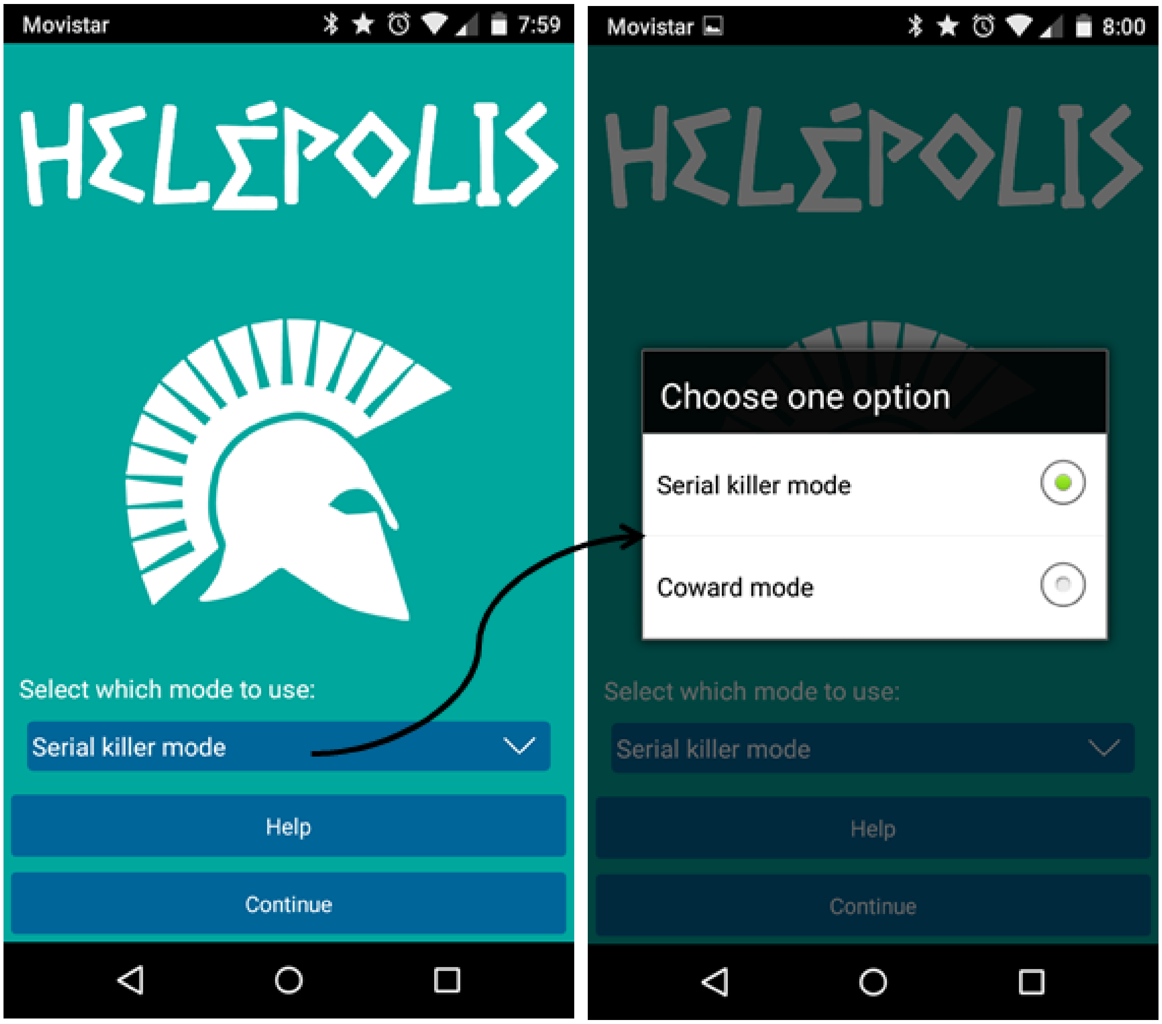


Figure 67: Control mode

4.2.4.1.3 Devices view

In the following view, a list with paired devices will be shown to the user. In case that the robot's Bluetooth module has not been paired yet, press 'Find other devices'. In any of the lists shown, a device must be selected to finish setup and connect with the device.

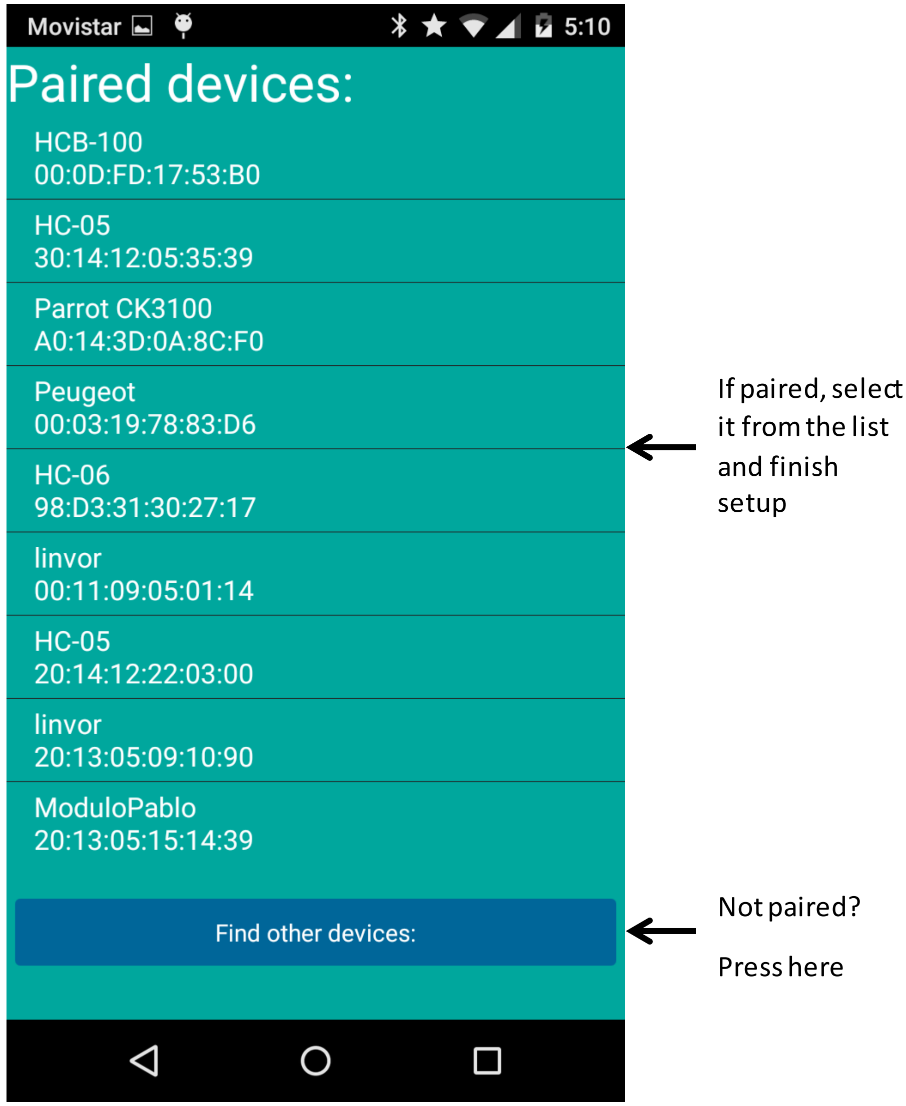


Figure 68: Bluetooth device selection list

As you may have notice, there may be many devices sharing the name but not the address as every device must have a unique one. In case of desiring to change device's name, you can consult this guide at Instructables.

4.2.4.1.4 Control view

With this view shown and the connection has been made among the mobile phone and robot, it is possible to control not just the movements, but the lights as well. The possibilities are:

-Front and back leds: There are three modes applied to these lights:

-Automatic mode: Depending on the direction, leds will be on or off.

-Manual mode on: Leds will be always on.

-Manual mode off: Leds will be always off.

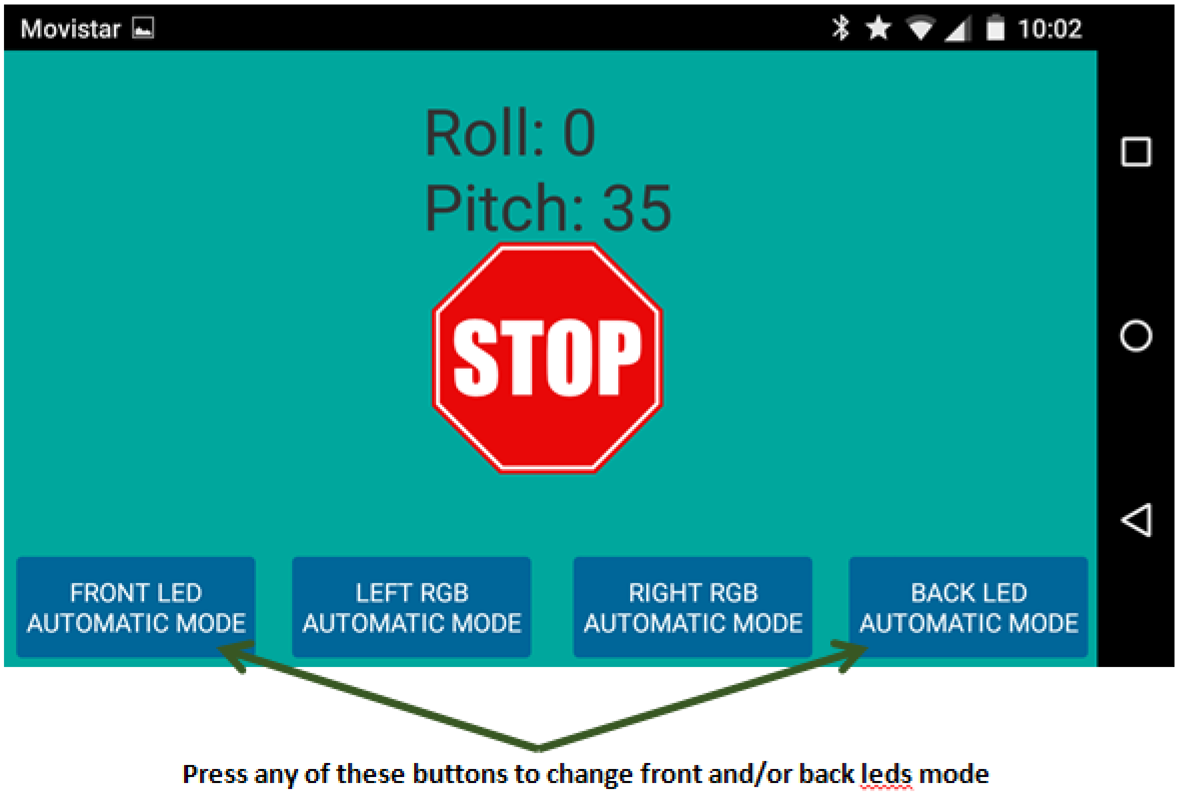


Figure 69: Front/back leds selection options

-RGB leds: These leds can be controlled individually in the following modes:

> -Automatic mode: Colour will be chosen automatically for both leds, depending on each wheel speed.
>
> -Manual mode: This mode lets the user choose red, green and blue levels for any of the RGB leds.

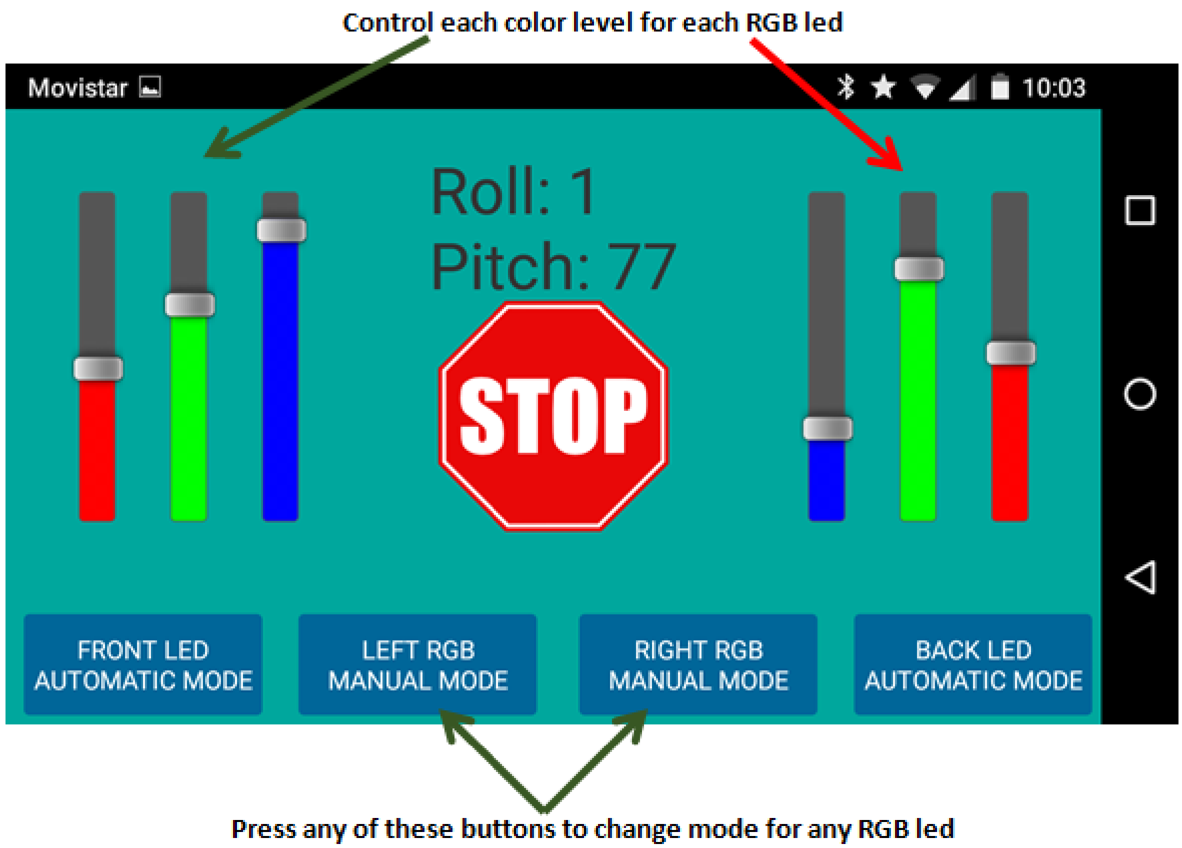


Figure 70: RGB selection options

If the user desires to end communication with the robot, stop button or back button should be clicked. Please note that sometimes it can take time (usually around milliseconds) to send the order that will make the vehicle stop.

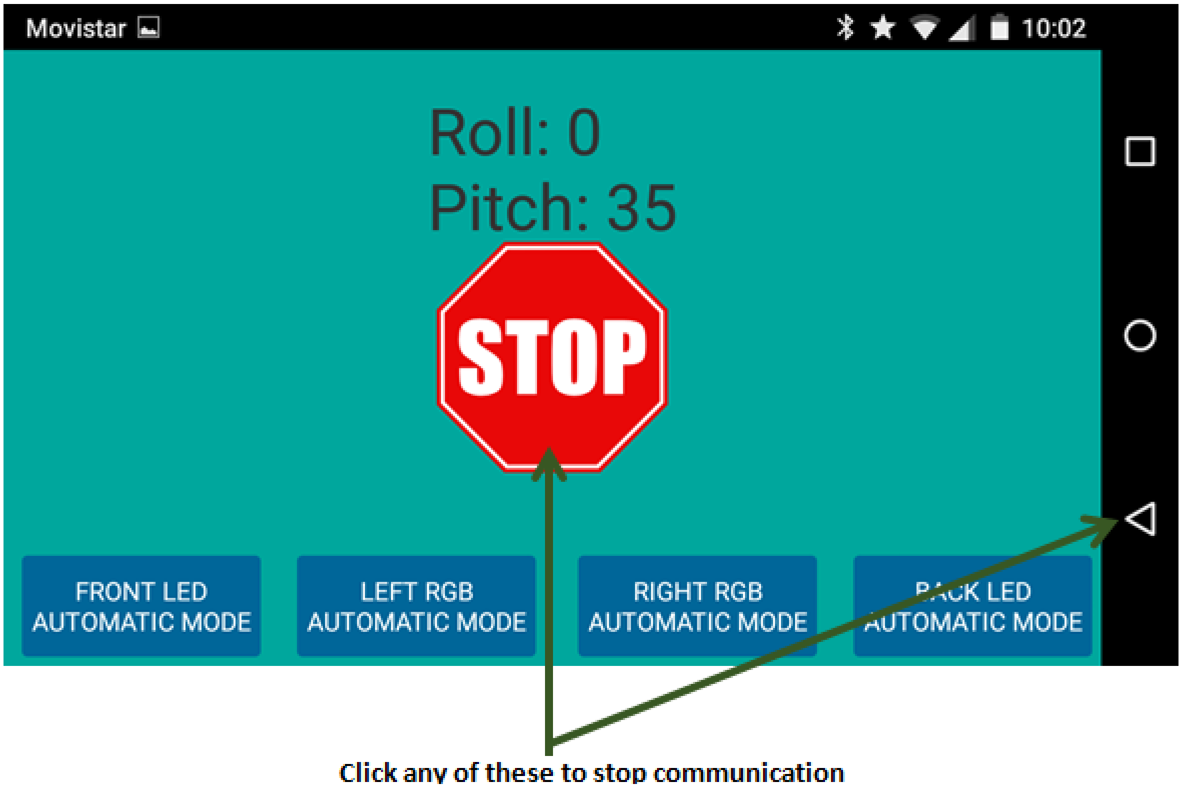
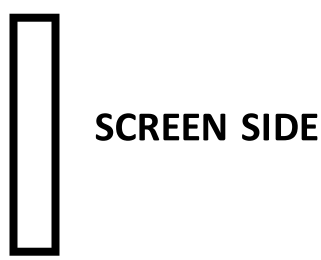


Figure 71: Communication ending options

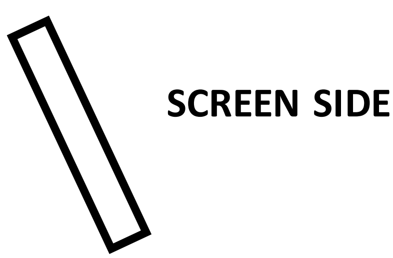
4.2.4.2 Movement control

In order to control how the robot moves, device's accelerometer is used and data is processed to send data to Arduino board, which will know how to use that data. There are two sorts of controls, which are direction and turn control. For direction control:

DO NOT MOVE



MOVE FORWARD



MOVE BACKWARDS

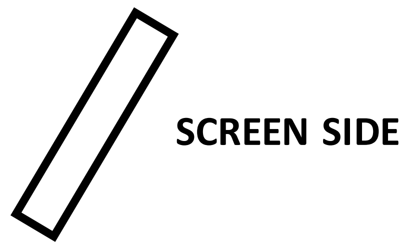
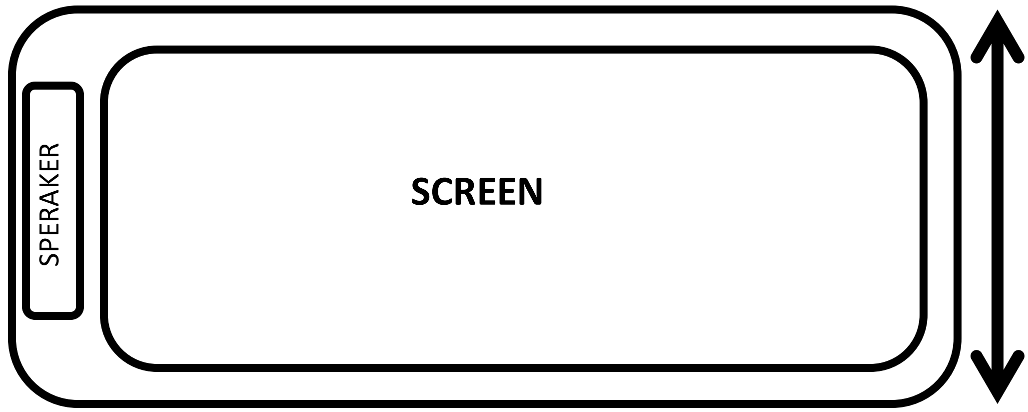


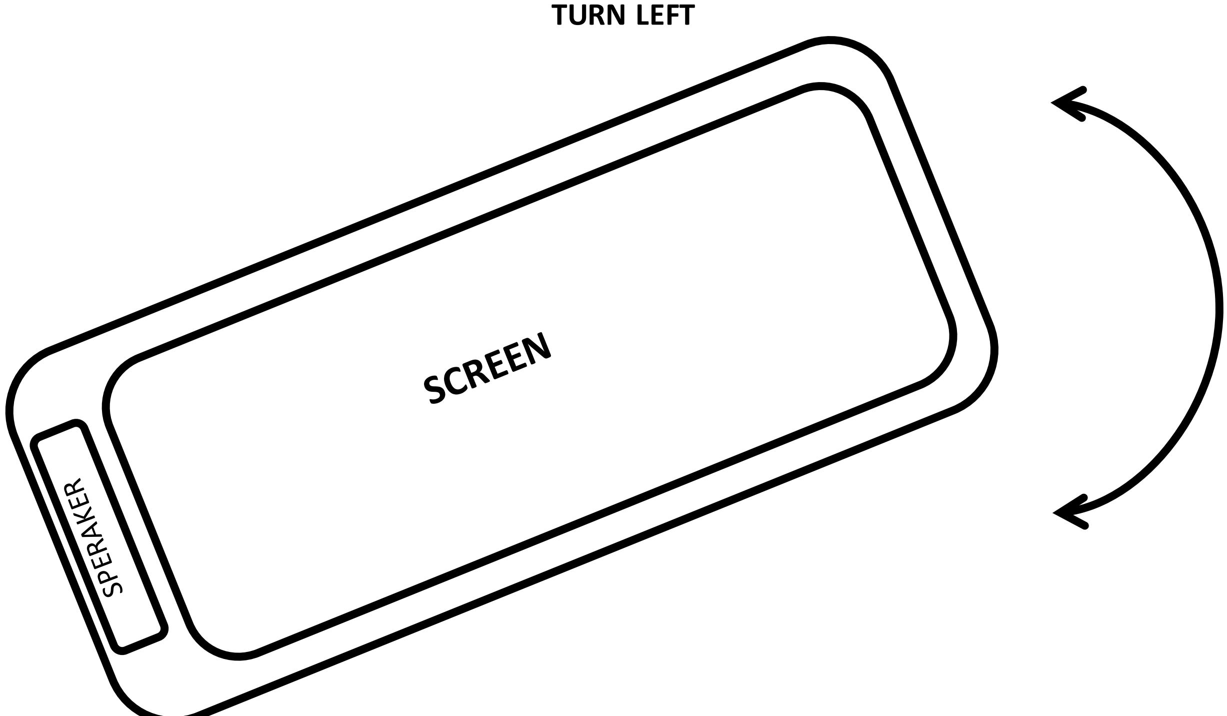
Figure 72: Movement options

For turn control:

STRAIGHT



TURN LEFT



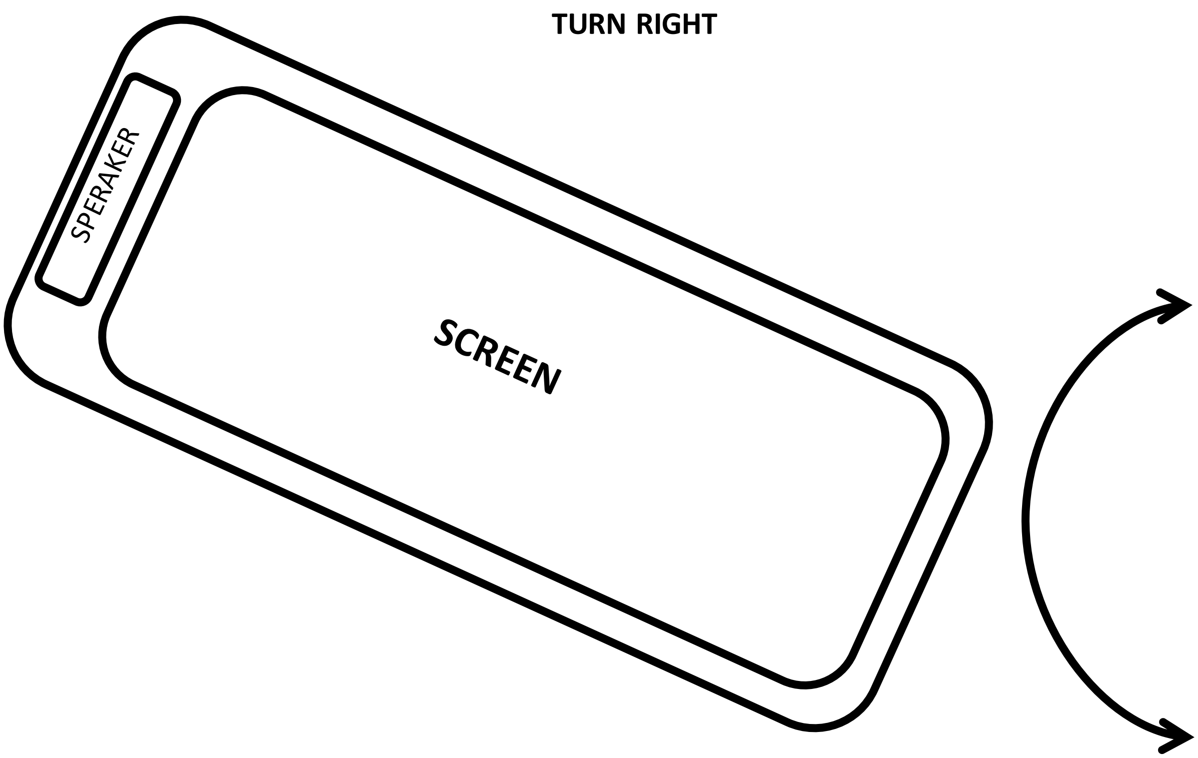


Figure 73: Turning options

4.2.4.3 Communication among Android device and Arduino

In case that the user of the application desires to communicate with another robot or vehicle, it is explained in this part of the document how the data is sent through both parts of the communication stream. The communication among peers works the following way:

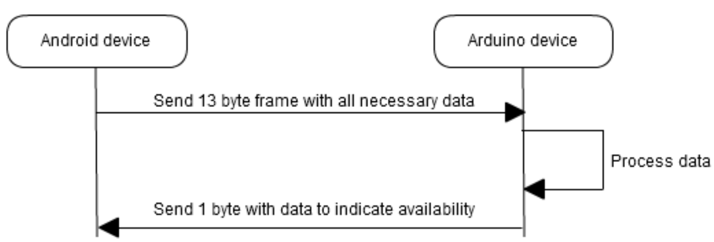


Figure 74: Android-Arduino communication

The data sent from Android application to Arduino device is a 13 byte frame as the following:

Data	Direction	Left wheel speed	Right wheel speed	Front leds mode	Back leds mode	Left RGB Mode
Data length	1 byte	1 byte	1 byte	1 byte	1 byte	1 byte

Left red value	Left green value	Left blue value	Right RGB mode	Right red value	Right green value	Right blue value
1 byte	1 byte	1 byte	1 byte	1 byte	1 byte	1 byte

Figure 75: Data frame for Bluetooth communication

5. About The Logo

This section gives information about the logos related to *AETEL Helepolis, for both robot and application*.

5.1. AETEL Helepolis Logo

The Logo of the *AETEL Helepolis* was made out of this image[10] found on the internet with no license.

Figure 76: Logo Greek Hoplite Source

The *AETEL Helepolis* Typography was designed by Ricardo Sanz (Contact through ricardosanz1b@gmail.com), a member of AETEL.

Figure 77: Logo AETEL Helepolis Typography

[10] Greek Hoplite (nd), Sparta300, http://users1.ml.mindenkilapja.hu/users/sparta300/uploads/2907.jpg

5.2. *AETEL Helepolis* App Logo

The Logo of the *AETEL Helepolis* App was also designed by Ricardo Sanz (Contact through ricardosanz1b@gmail.com).

Figure 78: Logo AETEL Helepolis App

6. Image and Figure Index