

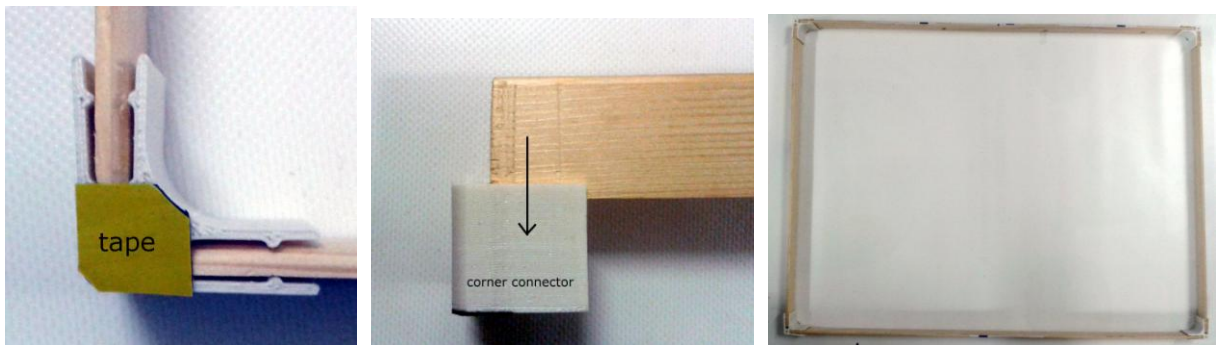
ELISA-3 TRACKING SET

The content of the set includes:

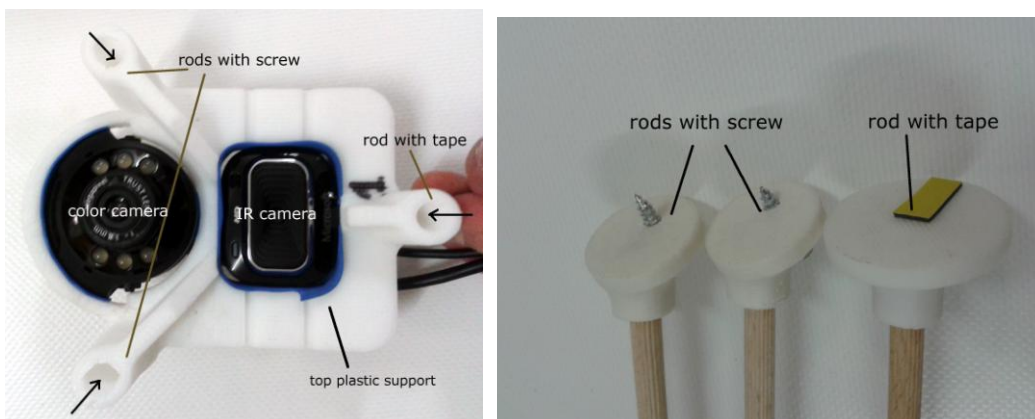
- 6 Elisa-3 robots
- 2 charging stations
- 1 radio module
- 1 IR camera and 1 color camera (both USB)
- 4 wood strips for the environment edges (2 x 60 cm long + 2 x 80 cm long)
- 4 plastic connectors for the wood strips
- 3 wood rods 1 m long and related plastic base
- 1 plastic support for the 2 cameras

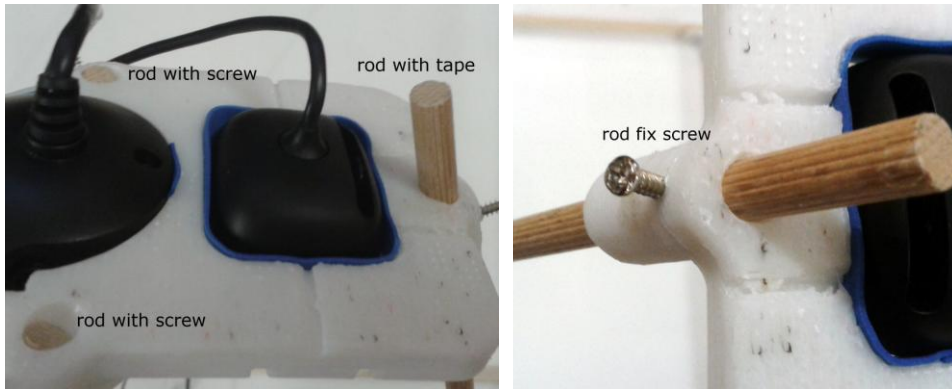
Assembly

1. Connect the 4 corner connectors with the related wood strips in order to get a rectangle environment. To easily insert the wood strip to the connector you need to slide it inside from top to bottom. Beware that the connectors have a piece of tape in one of its side, this double-face tape will be used to fix the environment to the ground/wall thus keep them to the same side.

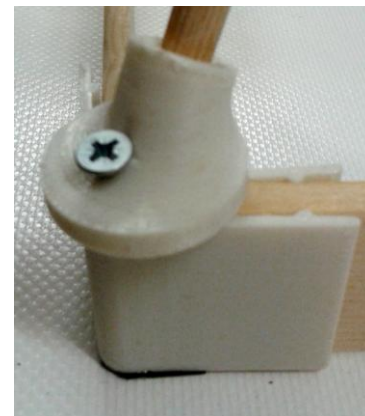
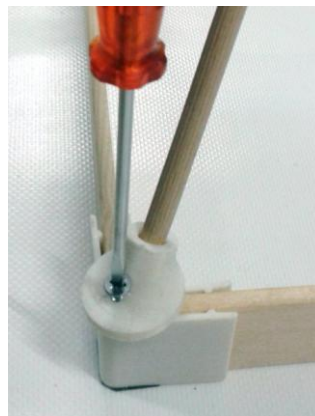
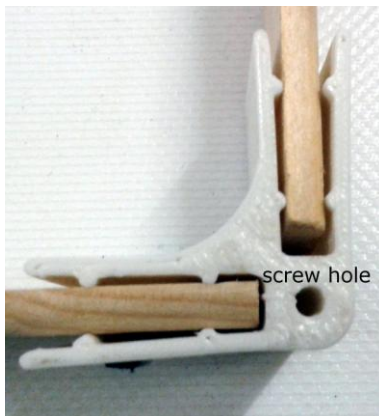
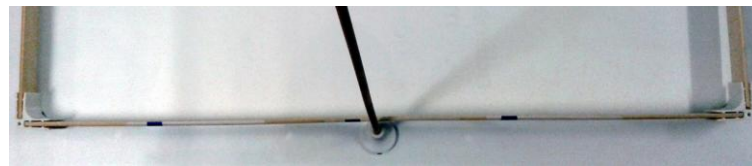
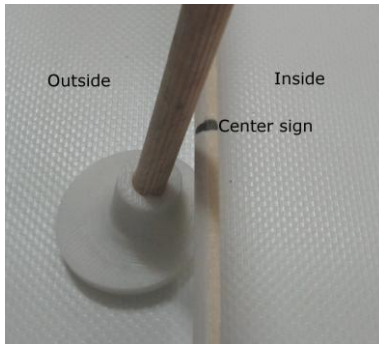


2. Fix the environment to the ground or wall using the plastic connectors tape. In the future if you want to change the position of the environment you'll need to replace the double-face tape.
3. Insert the 3 wood rods into the corner holes of the top plastic support until they cover completely the holes; pay attention to the correct direction (back of the cameras on the top). One of the rods base has the double-face tape on the bottom, the others two have a screw; the rod with the tape need to be inserted to the the small round hole above the IR camera, the others two need to be inserted to the remaining holes in the corners. The rod with the tape need to be also inserted leaving about 5 cm above the top plastic support. Goal is to have the cameras above the center of the arena. After the rods are inserted you can fix them with the little screw on the plastic support.

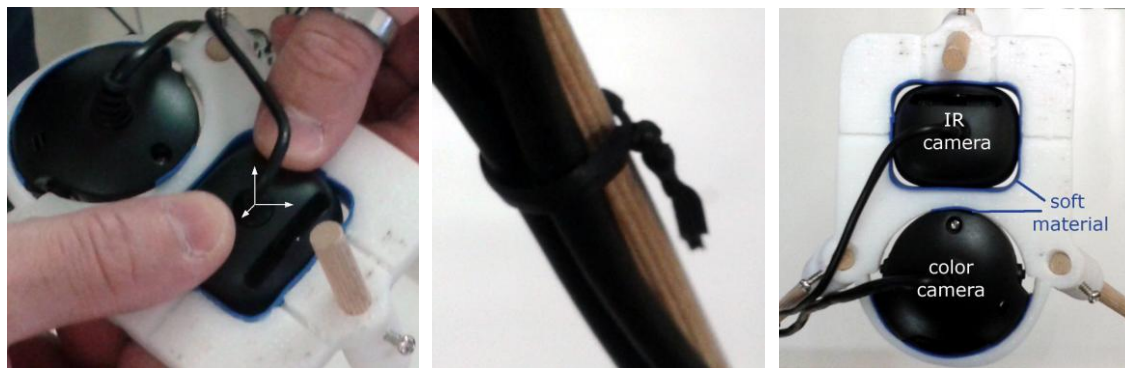




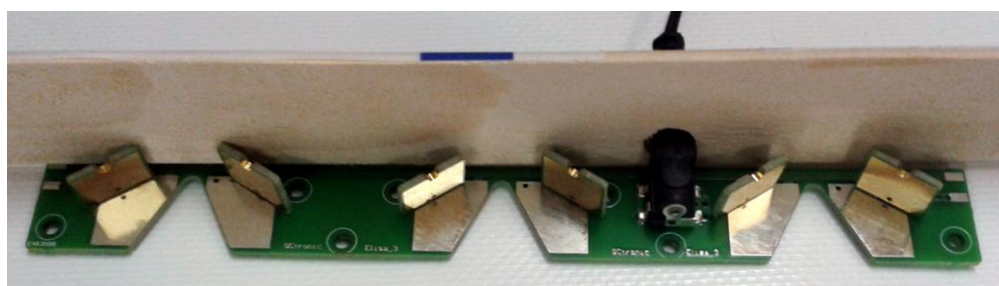
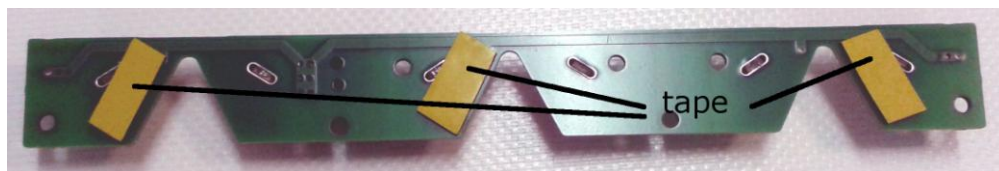
4. The two feet with the screw need to be screwed to the corner connectors that join longer wood strip without holes in it; all the plastic connectors have a little hole for the purpose of screwing the plastic base. The remaining foot with the tape need to be fixed to the ground outside the environment, just near the opposite edge (the other longer wood wall strip with holes in it) at about the center of the edge (there is a sign indicating the center). It is better that the rod is not touching the wall in order to not pick up vibrations.



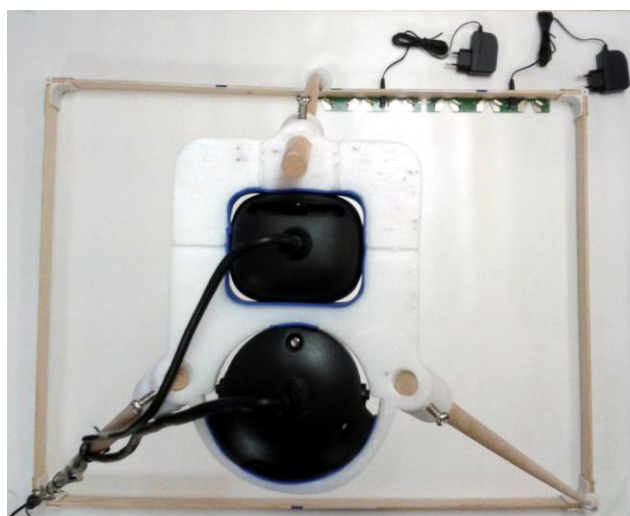
5. There are two big holes in the top plastic support, they are used to insert the two cameras. The IR camera will be inserted in the rectangular hole, the color camera in the round hole. From the top push the two camera in their respective places. In the border of the holes there is a little layer of soft material that will let you center the camera view and hold it in that position. In order to avoid to have the USB cables floating around or worse in the camera view, you can attach them to the wood rods.



6. It is not required but you can also put one or more charging stations inside the environment for autonomous docking of the robots. One of the wood strip has some holes that you can use to let the power cord pass through. The charging stations have some double-face tape in the bottom side that you can use to fix them on the ground.

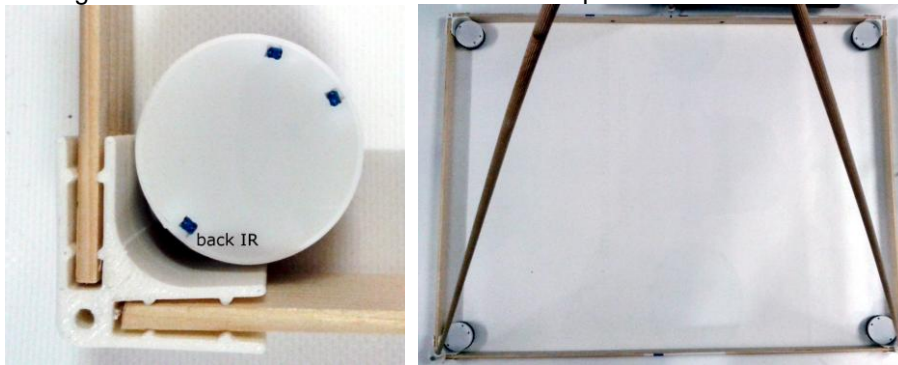


7. The final result is:

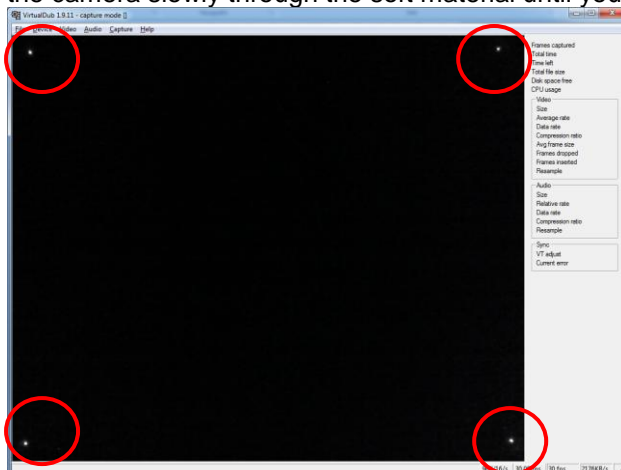


Camera configuration and positioning

1. Install the driver of the radio module. Windows users need to install the driver contained in the nRFgo Studio tool (<http://www.nordicsemi.com/eng/Products/2.4GHz-RF/nRFgo-Studio>), this let the radio module (base-station) be recognized as a WinUSB device (bootloader). Linux and Mac OS X users don't need any driver.
2. Go to the Elisa-3 wiki (<http://www.gctronic.com/doc/index.php/Elisa-3#Tracking>) and download the "turn on back IR" utility application (<http://www.gctronic.com/doc/index.php/Elisa-3#Utilities>). Extract it to your preferred location.
3. Connect the radio module to the computer with the provided mini USB cable, then turn on 4 robots putting the selector in position 15 for all robots. Place one robot in each corner of the environment, leaving the back IR transmitter led as nearest as possible to the corner.



4. Run the utility application "turn on back IR" (double click on "back-IR-on-4-robots\bin\Debug\back-IR-on-4-robots.exe"); it will ask you the 4 addresses of the robots for which to turn on the back IR led, give it the address of the robots you put in the environment.
5. Connect both the IR and color camera to the computer; if you need use some USB extension cables. Both cameras should be recognized automatically without the installation of any driver (tested on Windows 7).
6. Download virtualdub (<http://www.virtualdub.org/>) and install it; open it and select "File→Capture AVI..." to open the camera view. Under the "Device" menu select the "Microsoft LifeCam HD 3000" camera or the IR camera you use. You should end up with an almost completely black image (there should be already visible some white spots, they are the robots).
7. Adjust the IR camera position until you get all four robots (white spots) in the camera view; try to slide the camera slowly through the soft material until you get all robots within the window



robot IR LEDs

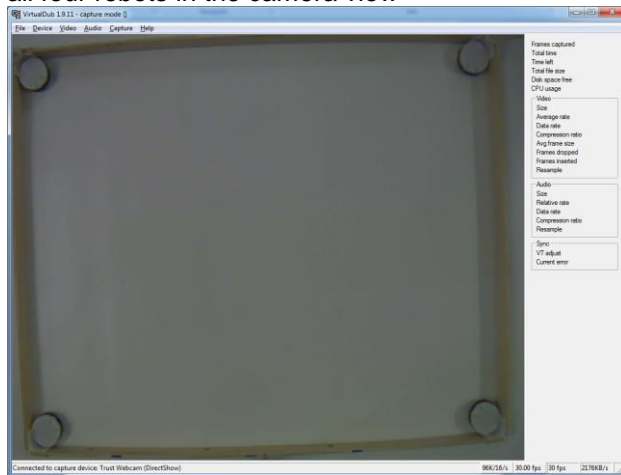
Before trying to center the camera view, make sure all the robot IR transmitters are actually turned on grabbing one after the other and placing them in the camera view and placing them back to their

corners. If one or more robots are off, execute again the “turn on back IR” utility (see point 4).

8. Select “Video→Set custom format...” and set VGA resolution (640x480); then select “Video→Capture filter...” and set the following settings:
 - disable auto exposure and set a value of “-9”
 - set contrast to maximum value
 - set brightness to 150

You can adjust these values based on your environment lighting. Goal is to see only the 4 IR LEDs of the robots clearly with as less noise as possible. Moreover you’ll need to reach an fps of at least 20 (see on the bottom right of the virtualdub window).

9. Now under the “Device” menu select the “Trust Webcam” camera and adjust its position until you get all four robots in the camera view



10. Exit from virtualdub: select “File→Exit capture”. The camera settings remain memorized in the camera until you disconnect it from the computer, thus you need to set again the previous settings with virtualdub each time you reconnect the camera to the computer.

11. Turn off the robots.

Application examples

1. Go to the Elisa-3 wiki (<http://www.gctronic.com/doc/index.php/Elisa-3#Tracking>) and download the SwisTrack software (<http://www.gctronic.com/doc/index.php/Elisa-3#SwisTrack>). Extract it to your preferred location.
2. Start SwisTrack: go to the directory “swistrack/SwisTrackEnvironment” and execute “SwisTrack - Release.exe”. For the moment reduce it to icon, we will use it later.

Position control of one robot

3. Turn on one robot and place it in the center of the environment; beware that the selector is in position 15.
4. Go to the Elisa-3 wiki (<http://www.gctronic.com/doc/index.php/Elisa-3#Tracking>) and download the position control example application “Horizontal position control (1 robot)” (http://www.gctronic.com/doc/index.php/Elisa-3#Position_control). Extract it to your preferred location.
5. Resume SwisTrack and open the configuration file named “elisa-3-usb.swistrack” contained in the directory “swistrack/SwisTrackEnvironment” (select “File→Open” and select the configuration file). Basically this configuration file contains the settings of the camera and the image processing components used to track the robots; moreover it specifies to publish the tracking information to the TCP port 3000.

6. Start the SwisTrack processing by clicking the “Run” button you find on the top. Since the robot hasn’t yet its IR transmitters turned on, at the moment the robot isn’t detected. Don’t worry, when the position control will be executed its IR will be turned on and the robot will be detected.
7. Now you can start the position control example application by executing “`position-control-pattern-horizontal-1-robot/bin/Debug/position-control-pattern-horizontal-1-robot.exe`”. The application will ask you the address of the robot you want to control, pass it the address of the robot you already have in the environment. Initially there is a calibration phase in which the robot will rotate in place, then the robot should start moving following a square shape.
8. In SwisTrack you can select the “Nearest Neighbor Tracking” component (click on it) in order to see on the screen the tracking results.

Position control of four robots

3. Turn on 4 robots and place them near the center of the environment (place them away from the border for a clean start); beware that the selector is in position 15 for all robots.
4. Go to the Elisa-3 wiki (<http://www.gctronic.com/doc/index.php/Elisa-3#Tracking>) and download the position control example application “Horizontal position control (4 robots)” (http://www.gctronic.com/doc/index.php/Elisa-3#Position_control). Extract it to your preferred location.
5. Resume SwisTrack and open the configuration file named “`elisa-3-usb_4robots.swistrack`” contained in the directory “`swistrack/SwisTrackEnvironment`” (select “File→Open” and select the configuration file). Basically this configuration file contains the settings of the camera and the image processing components used to track the robots; moreover it specifies to publish the tracking information to the TCP port 3000.
6. Start the SwisTrack processing by clicking the “Run” button you find on the top. Since the robots haven’t yet their IR transmitters turned on, at the moment no robot is detected. Don’t worry, when the position control will be executed their IR will be turned on and the robots will be detected.
7. Now you can start the position control example application by executing “`position-control-pattern-horizontal-4-robots/bin/Debug/position-control-pattern-horizontal-4-robots.exe`”. The application will ask you the 4 addresses of the robots you want to control, pass it the address of the robots you already have in the environment. Initially there is a calibration phase in which the robots will rotate in place, then the robots should start moving following a square shape.
8. In SwisTrack you can select the “Nearest Neighbor Tracking” component (click on it) in order to see on the screen the tracking results.

More information on the tracking, the usage of the positions and examples are given in the wiki.

Additional informations

Camera settings

In the “Camera configuration and positioning” section you followed the steps to find the best parameters of the IR camera using `virtualdub`. You can modify the SwisTrack configuration files (“`elisa-3-usb.swistrack`” and “`elisa-3-usb_4robots.swistrack`”) in order to reflect the IR camera parameters you found with `virtualdub` (brightness, contrast and exposure values), this way the next time you want to start the tracking system you need to start only SwisTrack and the camera settings will be loaded automatically. In principle this procedure should work, but sometimes it was noticed that the settings passed from SwisTrack (based on OpenCV) aren’t accepted by the camera, so the camera need to be configured through `virtualdub` in this case.

The parameters in the files might be already correct.



Network connection with SwisTrack

SwisTrack is configured to publish the tracking information through a TCP connection. If you want to check, you can simply see these data using a simple terminal program like TeraTerm (<http://en.sourceforge.jp/projects/ttssh2/>) following these steps:

- Turn on one robot and place it in the camera view
- Execute the “turn on back IR” (pass it the address of the robot in the camera view, set 0 for the others)
- Open TeraTerm, select “File → New Connection”, specify TCP/IP with address 127.0.0.1 (the PC itself), specify “Other” in the “Service” section and insert 3000 as the TCP port number, then click “OK”
- You should start see the information on the particle detected; for more information on the messages refer to https://en.wikibooks.org/wiki/SwisTrack/Interfacing_SwisTrack.