SDK

Development center
User guide

2017

kinovarobotics.com

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OVERVIEW

The Kinova Development Center is a complete set of interface, documentation, examples and software tools that help the developer interact with any Kinova product. It is available under Ubuntu and Windows systems.

Content

- The Development Center
- The torque console
- A set of project examples
- User guide
- HTML documentation on all APIs
- Tools to configure your product

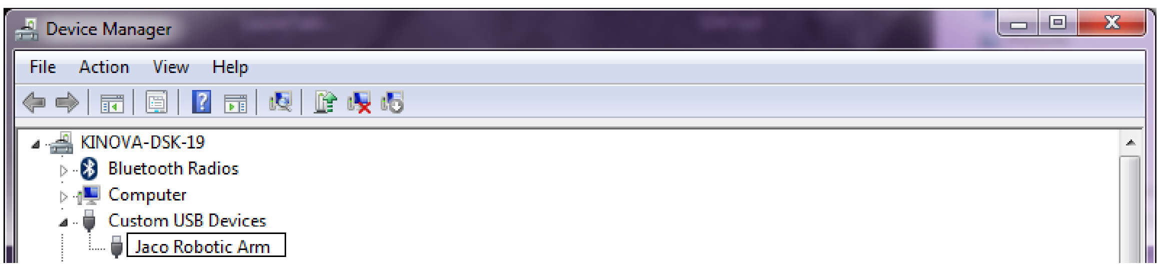
INSTALLATION

Windows 7

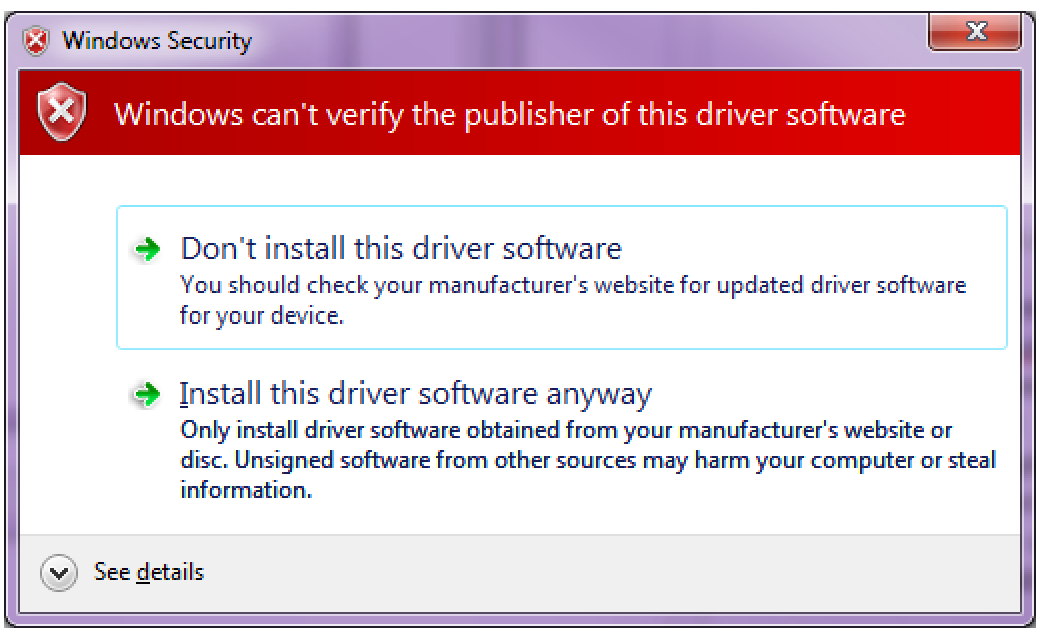
NEW INSTALLATION

If you have any Kinova products already installed on your computer, please refer to the UPDATE section. If it is your first installation of a Kinova product, follow the procedure below.

1. Download and install Microsoft Visual C++ Redistributable(x86, x64)
2. Execute the installer named **KinovaSDKInstaller**.
3. Connect the robot to your computer via USB.
4. Power on the robot.
5. In the Windows Control Panel, open the device manager and wait for the computer to detect a Custom USB Device.



6. Right click on the Kinova product that appeared and install the drivers that were copied on your disk when you executed the KinovaSDKInstaller. Assuming that you've installed the SDK in the default folder, it should be located at C:\Program Files (x86)\KinovaSDK\
7. A Windows Security window may appear:



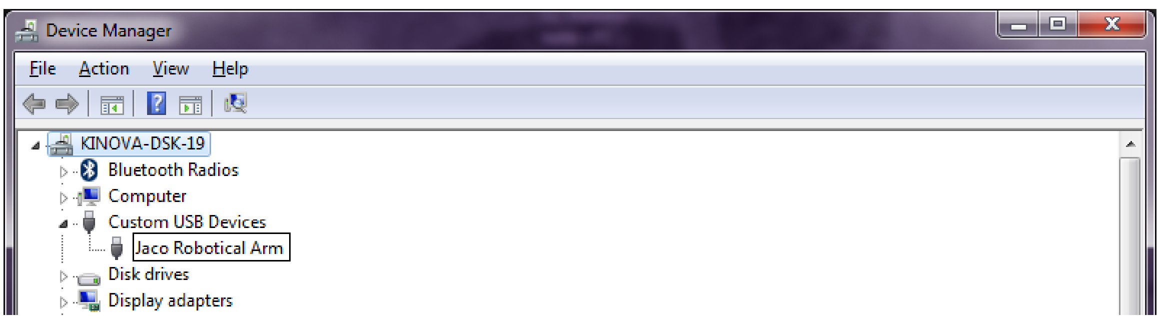
8. Choose to install the driver software anyway.
9. The Development Center is ready!

UPDATE

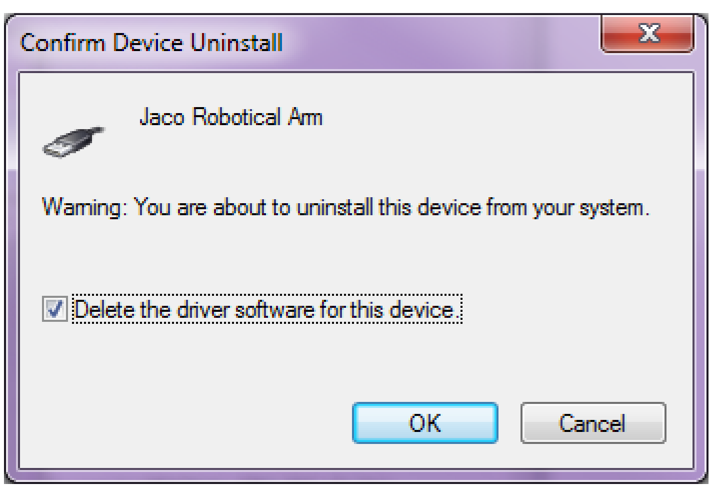
This section explains how to install the Kinova Development Center if you have any Kinova products already installed on your computer. This is necessary because the Kinova Development Center has a new driver which is different from the one used in previous versions of Kinova software products like Jacosoft. Note that it is possible to have different driver versions on different USB ports. As an example, you could install the previous USB driver on USB port A and when the robot is connected to that port, Jacosoft is available. At the same time, you could install the new driver on USB port B and when your robot is connected to that port, the new Development Center is available.

The procedure below explains how to completely uninstall a driver before installing the new Kinova Development Center.

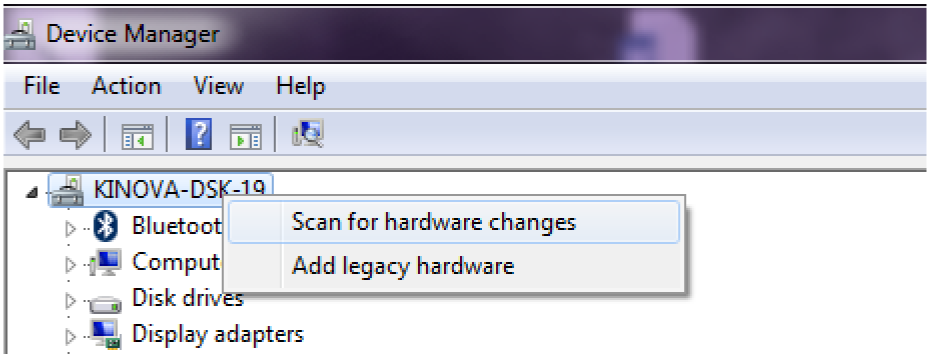
1. Connect the robot to your computer via USB.
2. Power on the robot.
3. In Windows Control Panel, open the device manager and look for the Custom USB Device called Jaco Robotical Arm.



4. Right click on it and choose *uninstall*



5. Check the option *Delete the driver software for this device* and click OK.
6. Stay in the device manager and right click on your computer. Choose *Scan for hardware changes*.

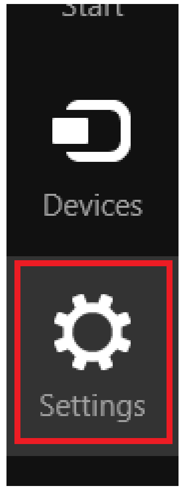


7. From here, follow the procedure in the section NEW INSTALLATION.

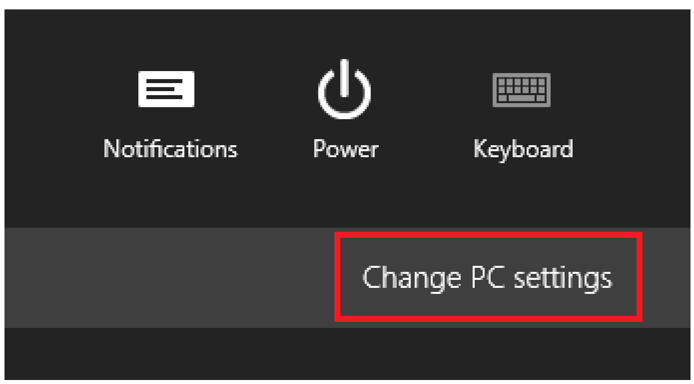
Windows 8.1

NEW INSTALLATION

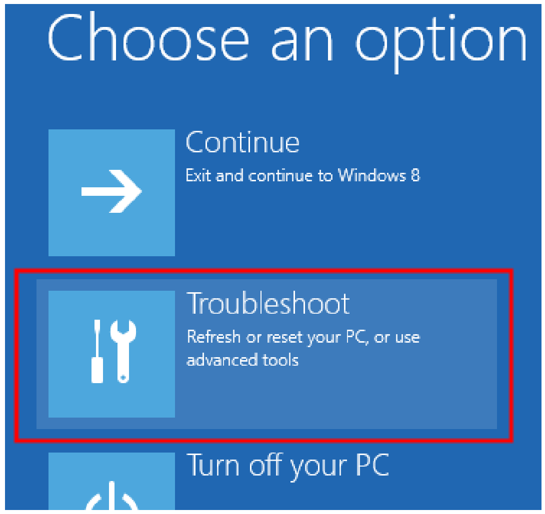
1. Move your mouse to the bottom-right corner of the screen and click on the *Settings* button.



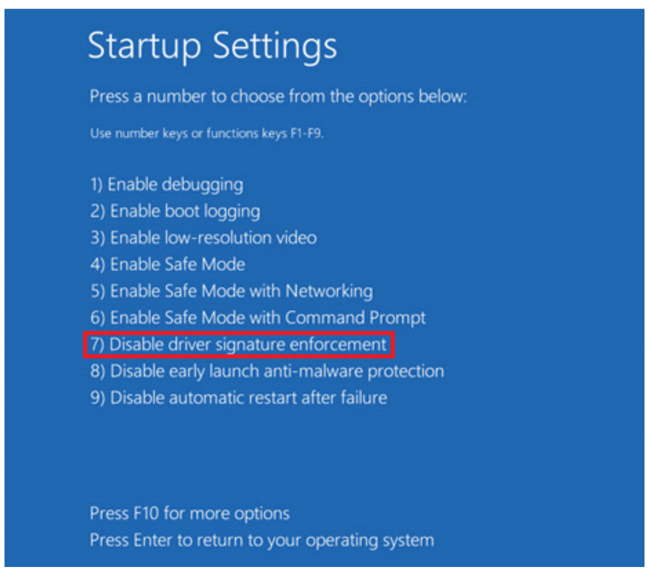
2. Click on the *Change PC settings* button located at the bottom of the menu.



3. Select the sub-menu *Update and recovery*.
4. Select the sub-menu *Recovery*.
5. Click on the *Restart Now* button located in the Advanced start-up section.
6. Wait until it restarts.
7. Select *Troubleshoot*.



8. Select *Advanced options*.
9. Select *Startup Settings*.
10. Click on the *Restart* button.
11. Press the *F7* key on your keyboard to disable the driver signature enforcement.



12. Right click on the bottom-left corner of the screen and select *Device Manager*.
13. From there, follow the same procedure as for Windows 7.

UPDATE

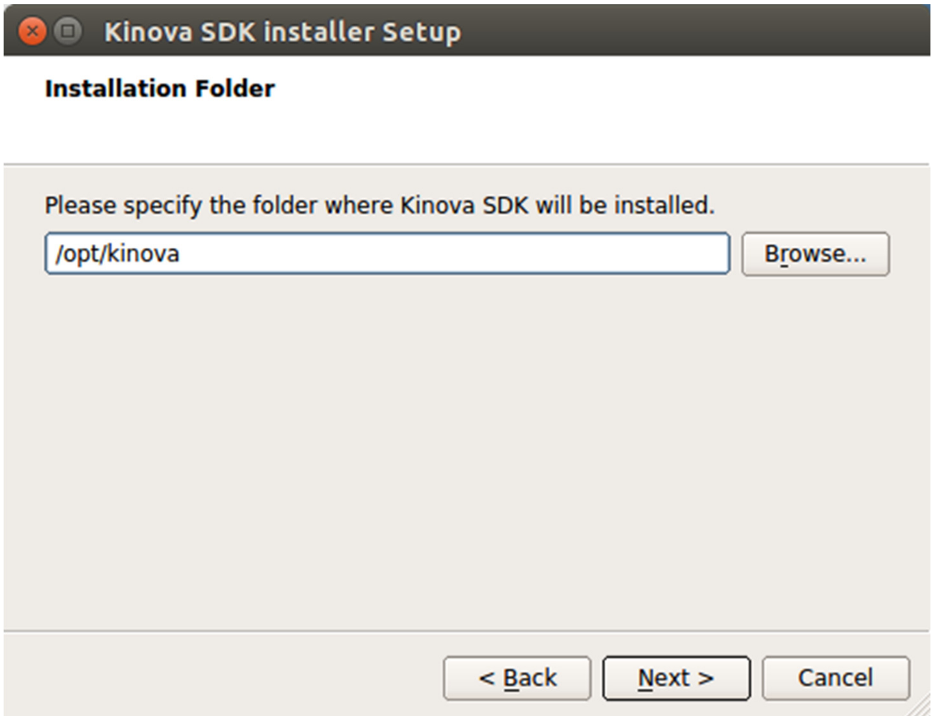
This section explains how to install the Kinova Development Center if you have any Kinova products already installed on your computer. This is necessary because the Kinova Development Center has a new driver that is different from the one used in previous versions of Kinova software products like Jacosoft. Note that it is possible to have different driver versions on different USB ports. As an example, you could install the previous USB driver on USB port A and when the robot is connected on that port, Jacosoft is available. At the same time, you could install the new driver on USB port B and when your robot is connected to that port, the new Development Center is available.

To install the Kinova Development Center, follow the same driver uninstallation procedure as in Windows 7 and proceed afterward to Windows 8.1 new installation.

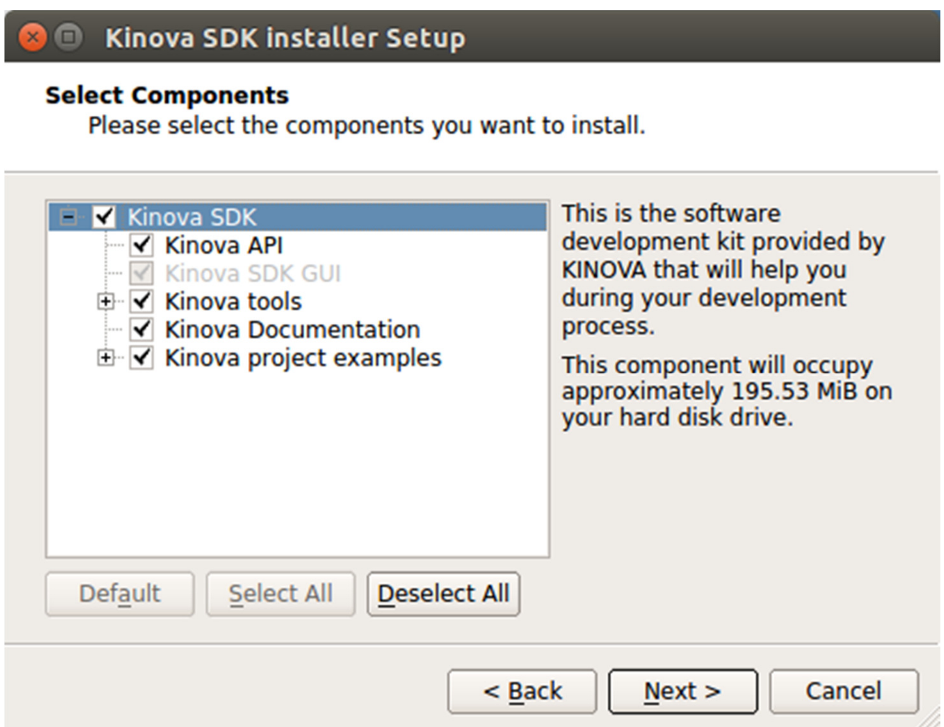
Ubuntu 12.04/14.04 installation

1. Execute the bash script named *installSDK32.sh* if your computer's architecture is 32 bits or *installSDK64.sh* if your computer's architecture is 64 bits.
2. The script will ask for root permission to install a package named kinova-api.
3. The Kinova SDK Installer Setup window will appear to install the remainder of the Development Center.

4. Choose an installation folder (default: /opt/kinova)



5. Choose which components you need to install.

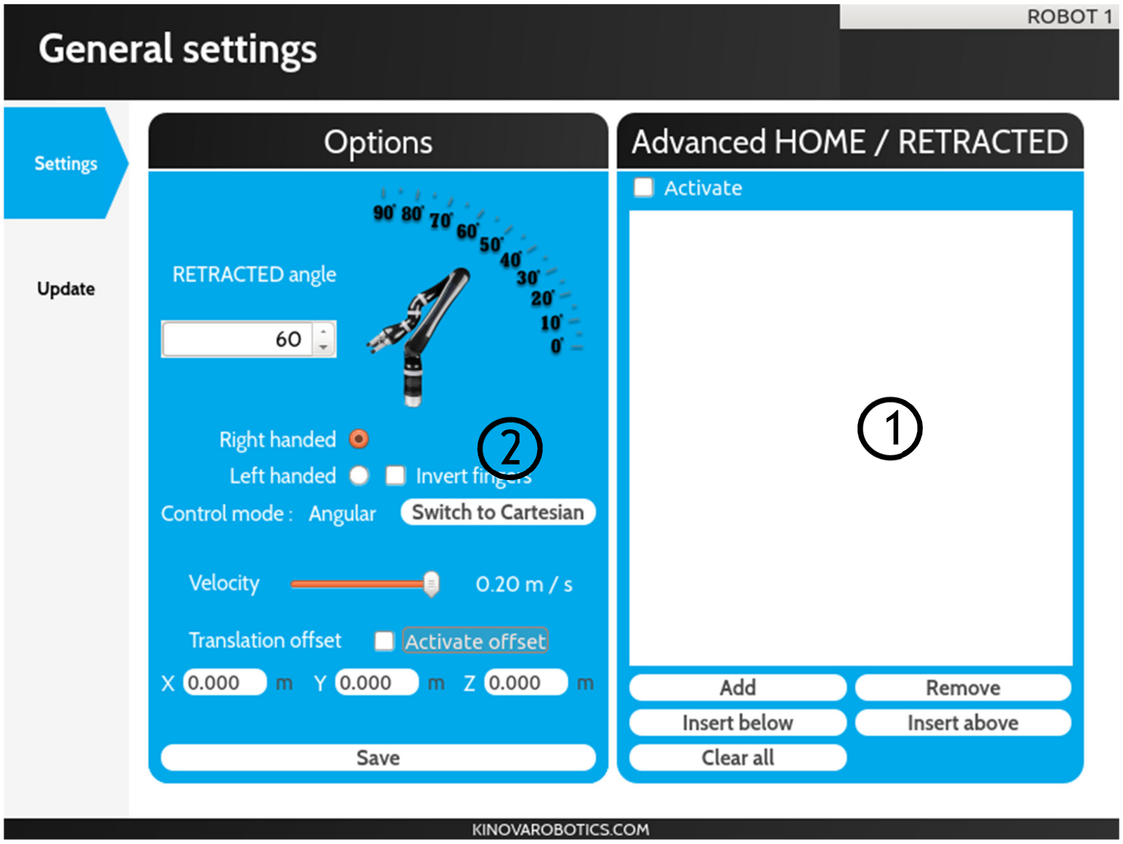


6. Click on the next button until the installation is completed.
7. The Development Center is installed. To launch the Development Center, execute [installation folder]/GUI/KinovaSDK.sh

DEVELOPMENT CENTER

General settings

SETTINGS



1 Advanced HOME / RETRACTED position

Activate	Check to enable the advanced HOME / RETRACTED feature.
List of positions	Contains the list of positions (angular or Cartesian) that represents the new path that the robot will follow between the HOME and the RETRACTED position.
Add	Click to add the current robot's position at the end of the positions list.

Remove	Click to remove the selected position from the position list.
Insert below	Click to add the current robot's position below the selected position in the positions list.
Insert above	Click to add the current robot's position above the selected position in the positions list.
Clear all	Click to clear the entire positions list.

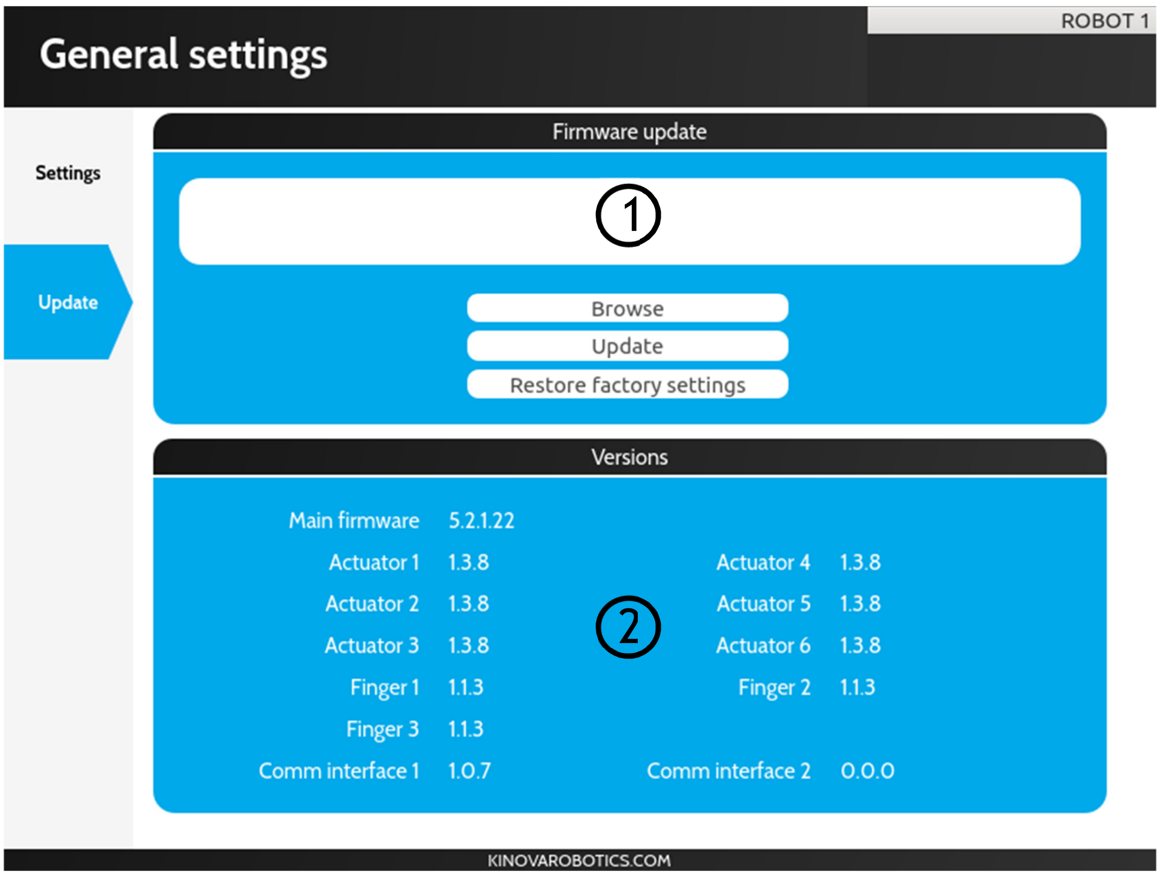
② Options

Retracted angle	The angle of the default RETRACTED position shown by the image aside.
Handedness	Select the radio button to set the robot in right handed mode or in left handed mode.
Invert fingers	Check to invert the closing finger when a 3 fingers robot is closing only 2 fingers. This mode is mainly used with a left handed configuration.
Control mode	Displays the current control mode. It can be either Angular or Cartesian.
Switch button	Select to toggle between the Angular control mode and the Cartesian control mode. Note that if the robot's position cannot switch to Cartesian mode because of a singularity, the robot will stay in Angular mode.
Velocity	Select the maximum Cartesian velocity of the robot.

Activate offset Check to apply a position offset on the end effector. The offset is described by the text fields X, Y and Z.

Save Press to send the modification to the robot. If you perform a modification in the Option panel nothing will be applied unless the save button is pressed. The exception is the velocity which is applied directly when modified.

UPDATE



① **Firmware update**

White panel Displays the complete path to the HEX file that will be uploaded to the robot when the button update is pressed.

Browse Press to choose a HEX file on your disk that contains a firmware update.

Update Press to update your robot with the chosen HEX file.

Restore factory settings Restore the robot with its factory settings.

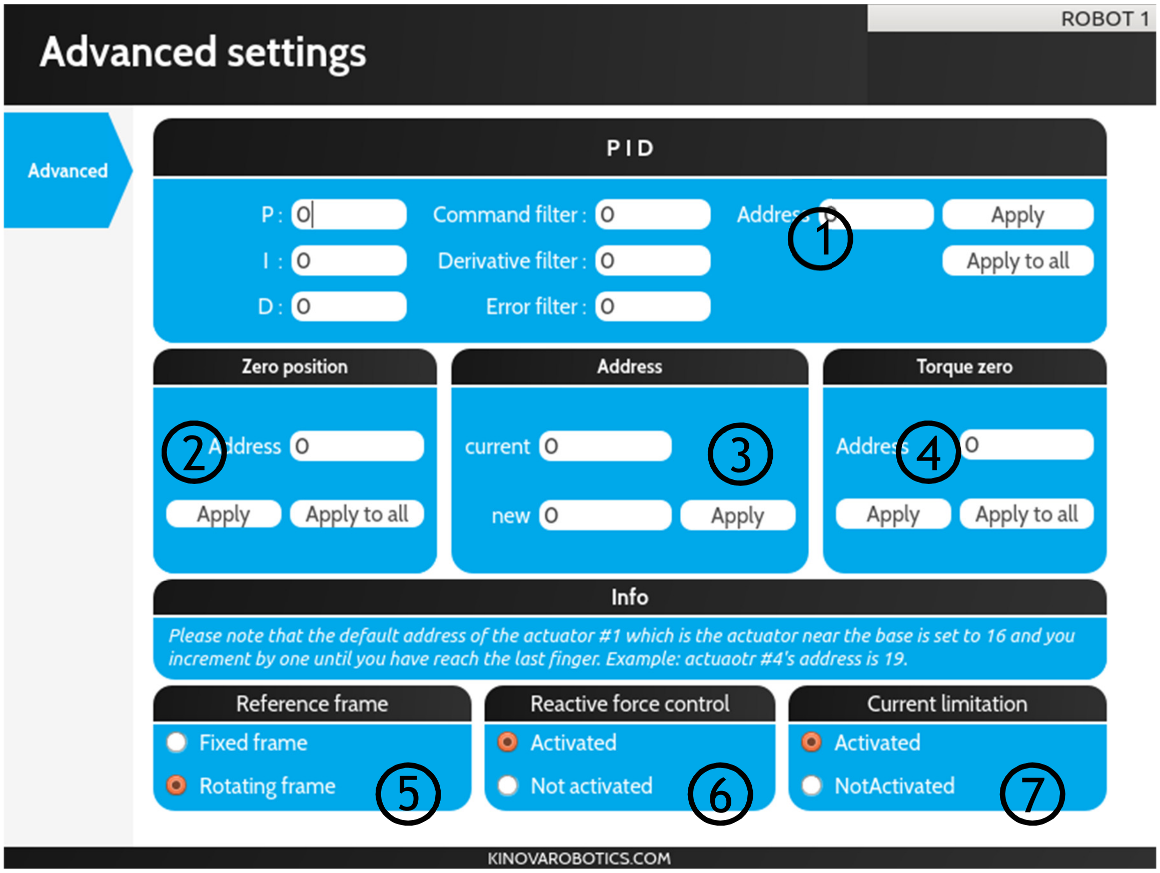
② Versions

Main firmware Displays the main firmware's code version.

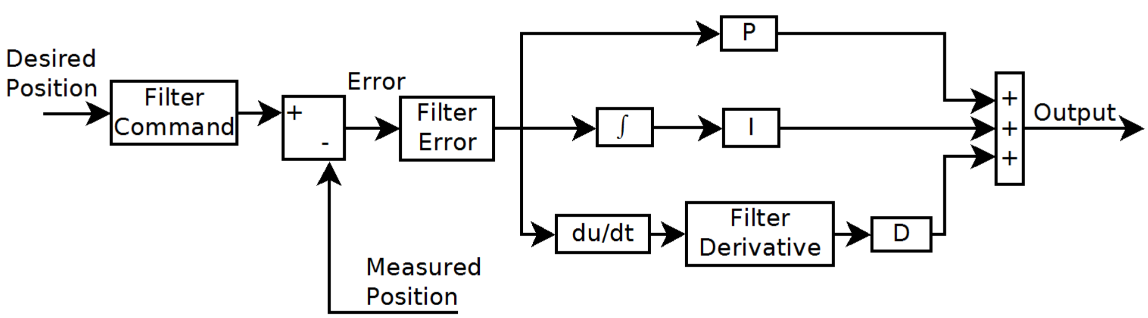
Actuator X Displays the code's version of the actuator X where X is a number greater than 0.

Finger X Displays the code's version of the finger X where X is a number greater than 0.

Advanced settings



1 PID (Proportional, Integral and derivative)



P	The proportional part of the controller. (Suggested range [0, 2])
I	The integral part of the controller.

D The derivative part of the Controller. (Suggested range [0, 0.1])

Command filter Filters the commands sent to the actuator. The filter is of first order and the parameter value is a frequency in rad/s. The suggested range is [0, 500].

Derivative filter Filters the error derivative signal (derivative of (desired position - measured position)). The filter is of first order and the parameter value is a frequency in rad/s. The suggested range is [0, 500].

Error filter Filters the error signal (desired position - measured position). The filter is of first order and the parameter value is a frequency in rad/s. The suggested range is [0, 500].

Address The address of the actuator to modify.

⚠ Setting these parameters out of the suggested range can severely damage the robot and is not covered by the warranty.

2 Zero position

Address The address of the actuator to modify.

Apply Apply the *zero position*. The actual position of the targeted actuator will now be 180°.

Apply to all Apply the *zero position* to every actuator of the robot.

⚠ Setting these parameters incorrectly can severely damage the robot and is not covered by the warranty.

③ Address

Current	The current address of the actuator.
New	The new address to assign.
Apply	Apply the new address on the actuator.
⚠	Setting these parameters incorrectly can severely damage the robot and is not covered by the warranty.

④ Torque zero

Address	The address of the actuator on which the *torque zero* will be applied.
Apply	Apply the *torque zero*. The actual torque of the targeted actuator will now be considered as 0
Apply to all	Apply the zero torque on every actuator of the robot.
⚠	Setting these parameters incorrectly can severely damage the robot and is not covered by the warranty.

⑤ Reference frame

Fixed frame	Set the robot to fixed frame. When a translation is performed, the orientation stays the same.
Rotating frame	Set to rotating. When a translation is performed, the orientation follows the first actuator (rotation in the XY plane).

⑥ Reactive force control

Activated	Select to activate the reactive force control (admittance mode).
Not activated	Select to deactivate the reactive force control (admittance mode).

7 Current limitation

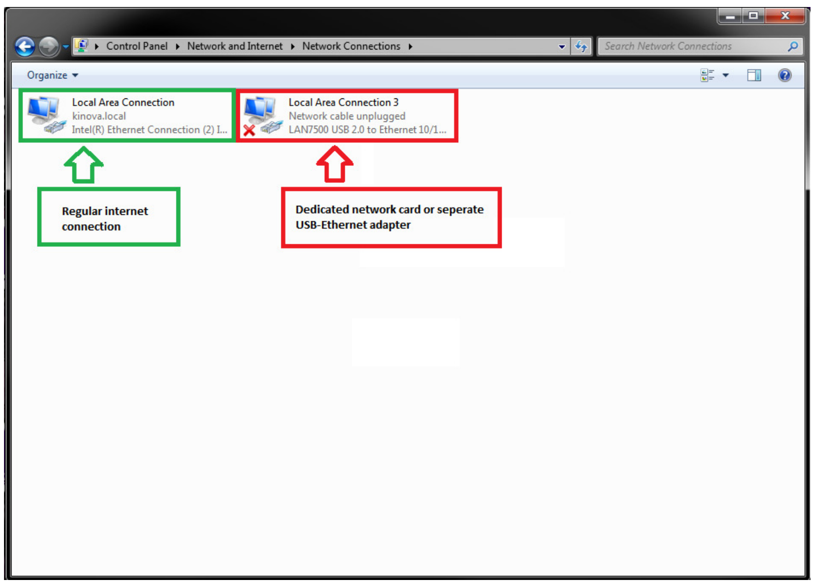
Activated	Select it to activate the current limitation.
Not activated	Select it to deactivate the current limitation.
⚠	Setting these parameters incorrectly can severely damage the robot and is not covered by the warranty.

Ethernet Default Configuration

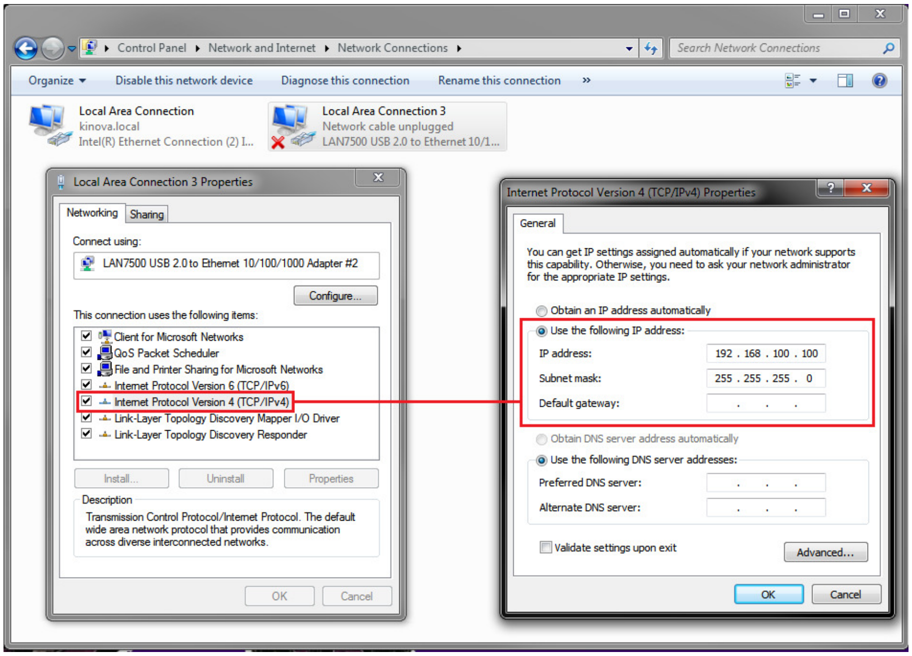
Kinova's JACO2 7DOF robotic arm ships with a default Ethernet configuration. In other words, the robotic arm already has a default IP address, subnet mask, port number and MAC address. These default parameters can be seen in the Development Center's **General settings > Ethernet** window with any given connected arm provided it supports Ethernet.

For a quick and easy set-up, we advise not to change these default parameters and to adapt your IP address to the arm's pre-configured Ethernet settings. The easiest way to achieve this is to use a separate Ethernet network card that will be dedicated to communicating with the robotic arm. A USB to Ethernet adapter can also be used.

The only requirement for the user is to set a static IPv4 address and a subnet mask for the dedicated network card (or adapter). This can be done by changing the adapter settings in the **Network and sharing center**.



Keep in mind that it is important for the user's static IP address to have the same subnet as the robotic arm (we advise to use a subnet mask of 255.255.255.0). You do not need to set a default gateway. Below is an example.

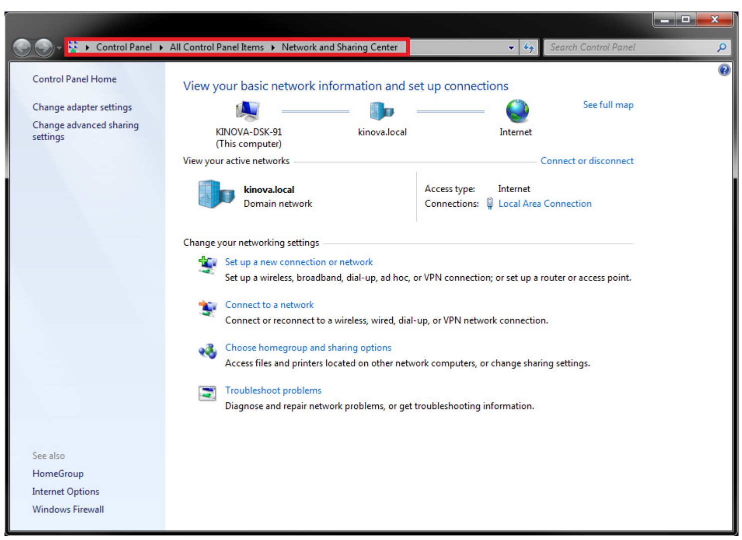


If the user wishes to modify his PC's dedicated static IP address and/or subnet mask to one of his choosing, the robotic arm's Ethernet settings will need to be configured accordingly. What follows is a step by step guide to modifying the Ethernet parameters (user's PC and robotic arm) to one parameters different from the default configuration.

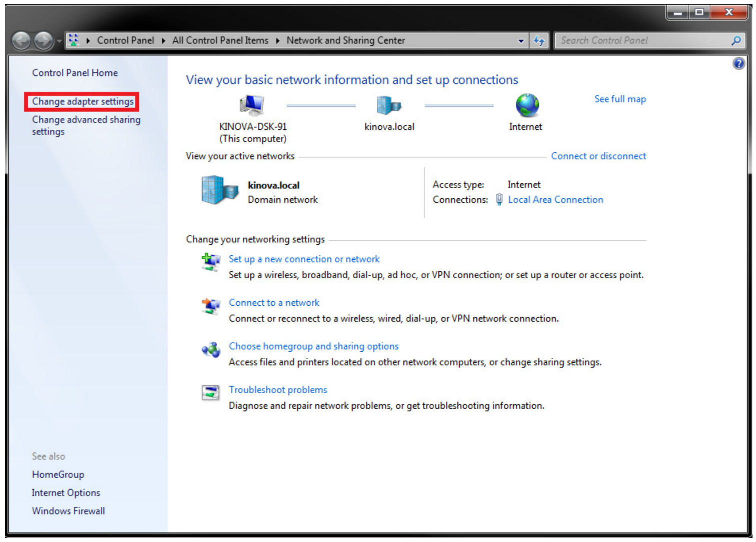
Ethernet Setup on PC

The following steps describe how to set up a static IP address on your computer. This IP address will then be used to communicate with the robotic arm.

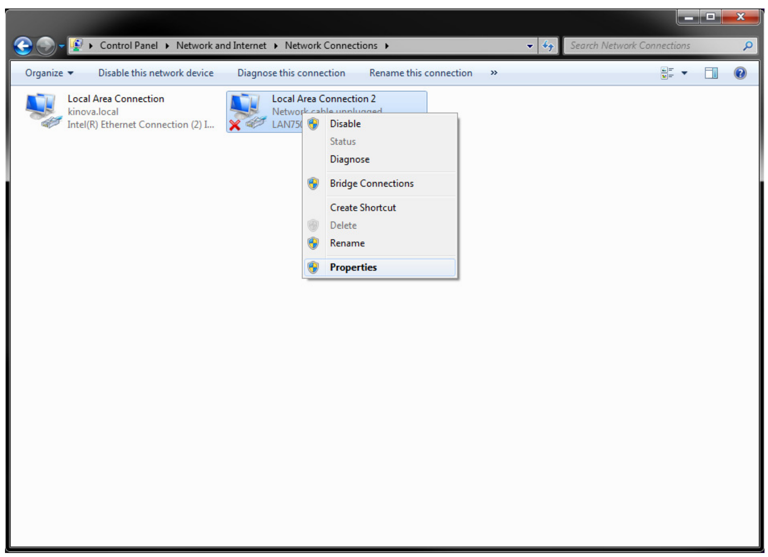
1. Navigate to **Control Panel > Network and Sharing Center**.



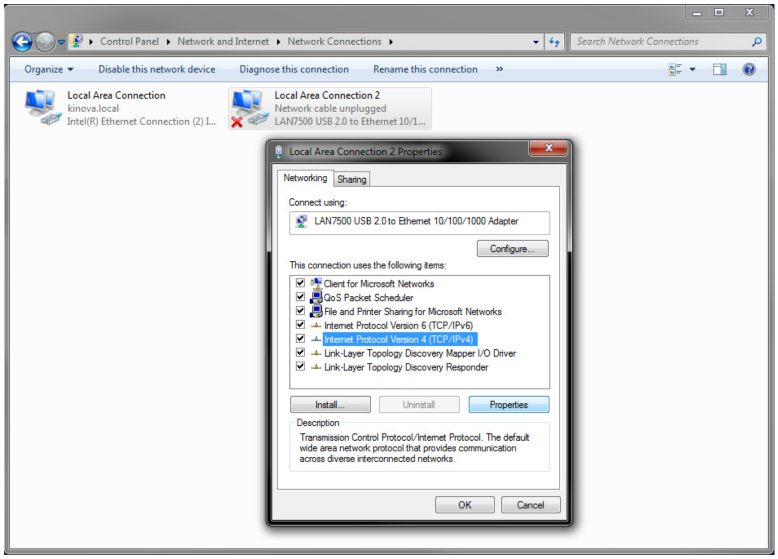
2. Click on ***Change adapter settings*** situated in the left column.



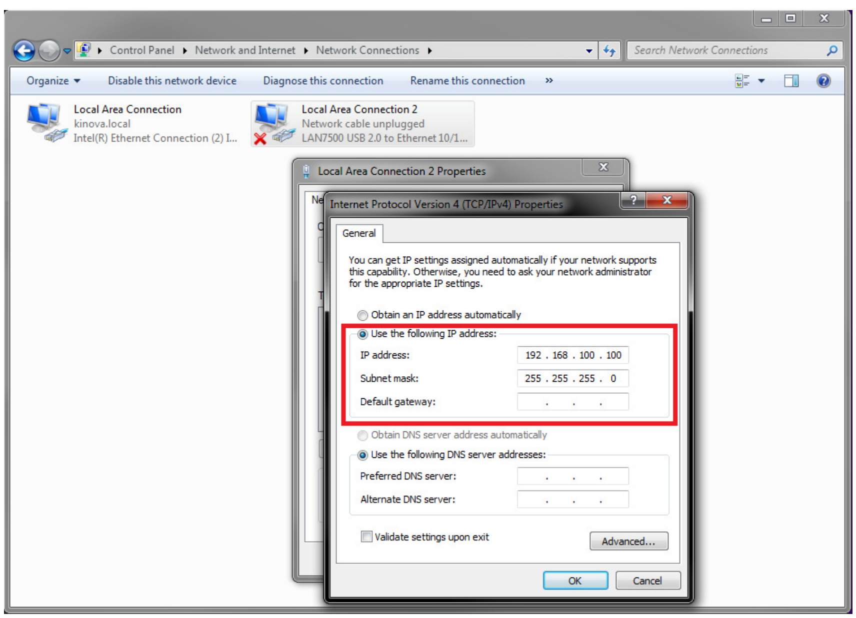
3. Right click on the desired connection and click on ***Properties*** from the drop down menu.



4. Select ***Internet Protocol Version 4 (TCP/IPv4)*** and click on ***Properties***.



5. Select ***Use the following IP address*** and fill out the pertinent information.
   a. The IP address should be the IP address you want to use to communicate with the robot. Make sure it is not already in use.
   b. The Subnet mask must be 255.255.255.0
   c. You don't need to set a Default gateway.

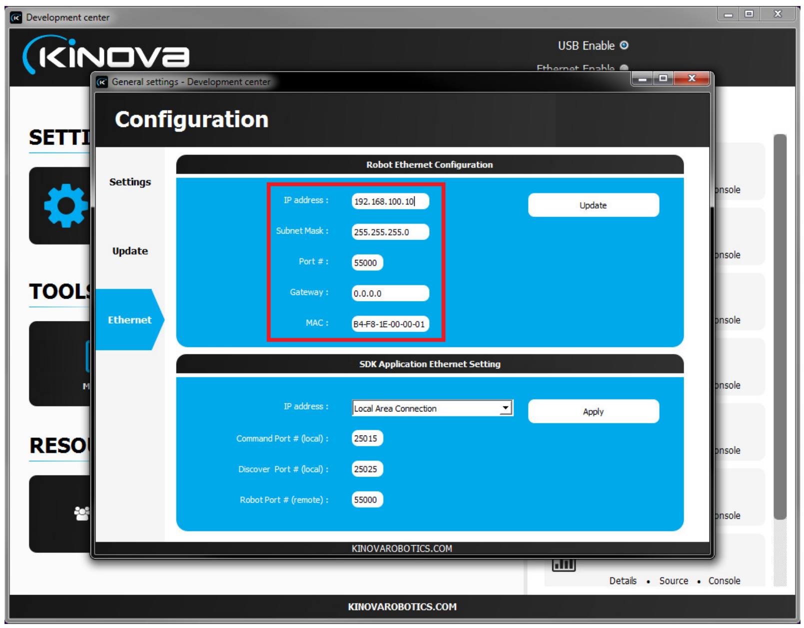


6. Click on **OK** and close the Control Panel. You have now set up a static IP address that will be used to communicate with the robotic arm.

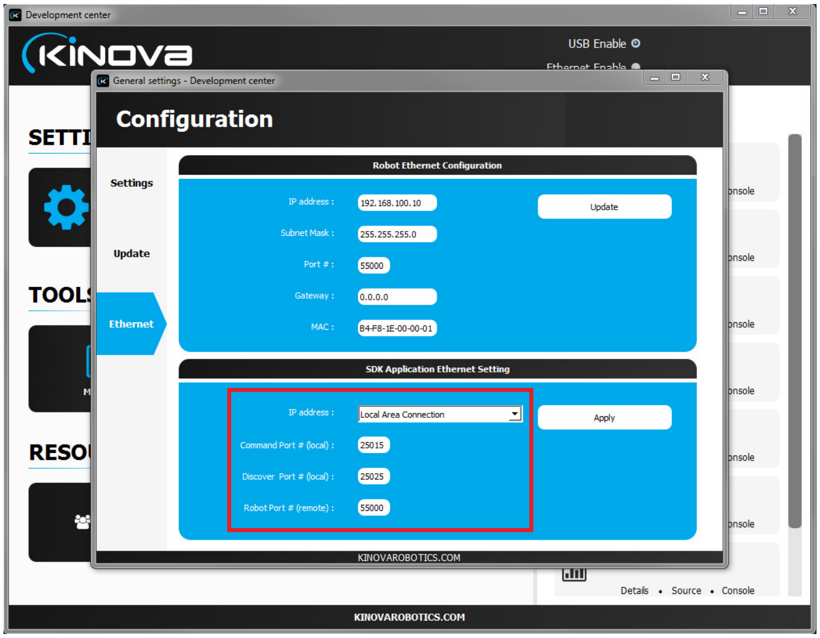
Ethernet Setup

The following steps describe how to set up the Ethernet configuration for the robotic arm.

1. Make sure the robotic arm is connected via USB and Ethernet cable simultaneously (this is required only for the first set-up).
2. Launch the Development Center.
3. Once the Development Center establishes a connection via the USB (serial number should appear next to the USB Enable tab), click on the serial number, click on ***General settings*** under the **SETTINGS & CONFIGURATION** tab and then click on ***Ethernet***.
4. Under the **Robot Ethernet Configuration** tab, fill out the required information (IP address, Subnet Mask, Port #, Gateway and MAC)
    a. The IP address should have the same subnet as your PC's static IP address.
    b. The subnet mask must be 255.255.255.0
    c. The port number can be any given port number (as long as it's not already in use).
    d. The Gateway must be 0.0.0.0
    e. The MAC address should be the one that has been provided.



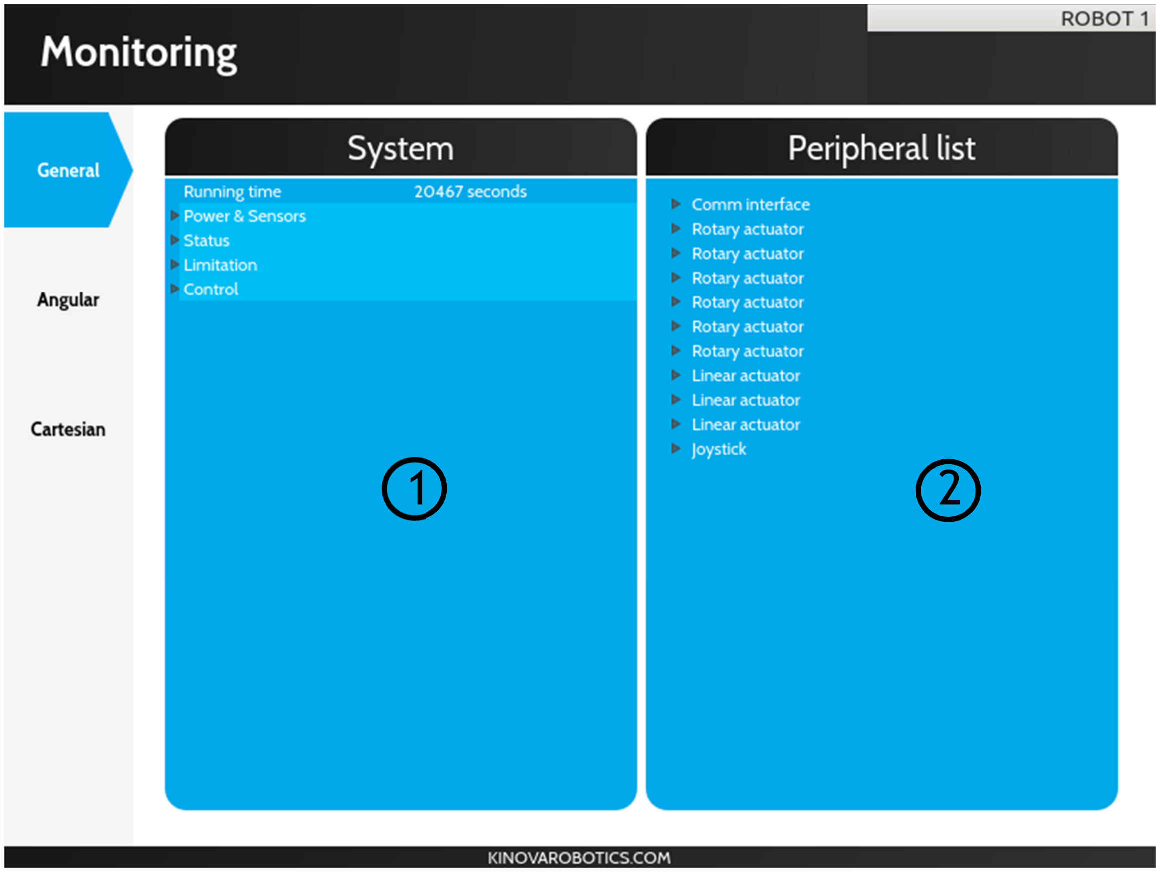
5. Under the **SDK Application Ethernet Setting** tab, fill out the required information (IP address, Command Port #, Discover Port #, Robot Port #)
    a. The IP address should be the connection with the static IP address you have configured on your PC.
    b. The Command Port number and Discover Port number can be any given port number (as long as it isn't already in use).
    c. *The Robot Port # must be the same as the Port # from the Robot Ethernet Configuration.*



6. Once all the information is filled out, first click on ***Apply*** and then on ***Update***. Close the Development Center and reboot your robotic arm.
7. Open the Development Center once again. Once the robotic arm's serial number appears on the top right corner, click on ***Ethernet enable***. At this point, the serial number will have disappeared from the top right corner and the Development Center will try and establish the connection via Ethernet.
8. Once the serial number appears once more in the top right corner, this signifies that an Ethernet connection has been established.
9. You can now unplug the USB cable from the robotic arm and control it via Ethernet. All subsequent connections to the robotic arm via the Development Center can be done directly with the Ethernet cable.

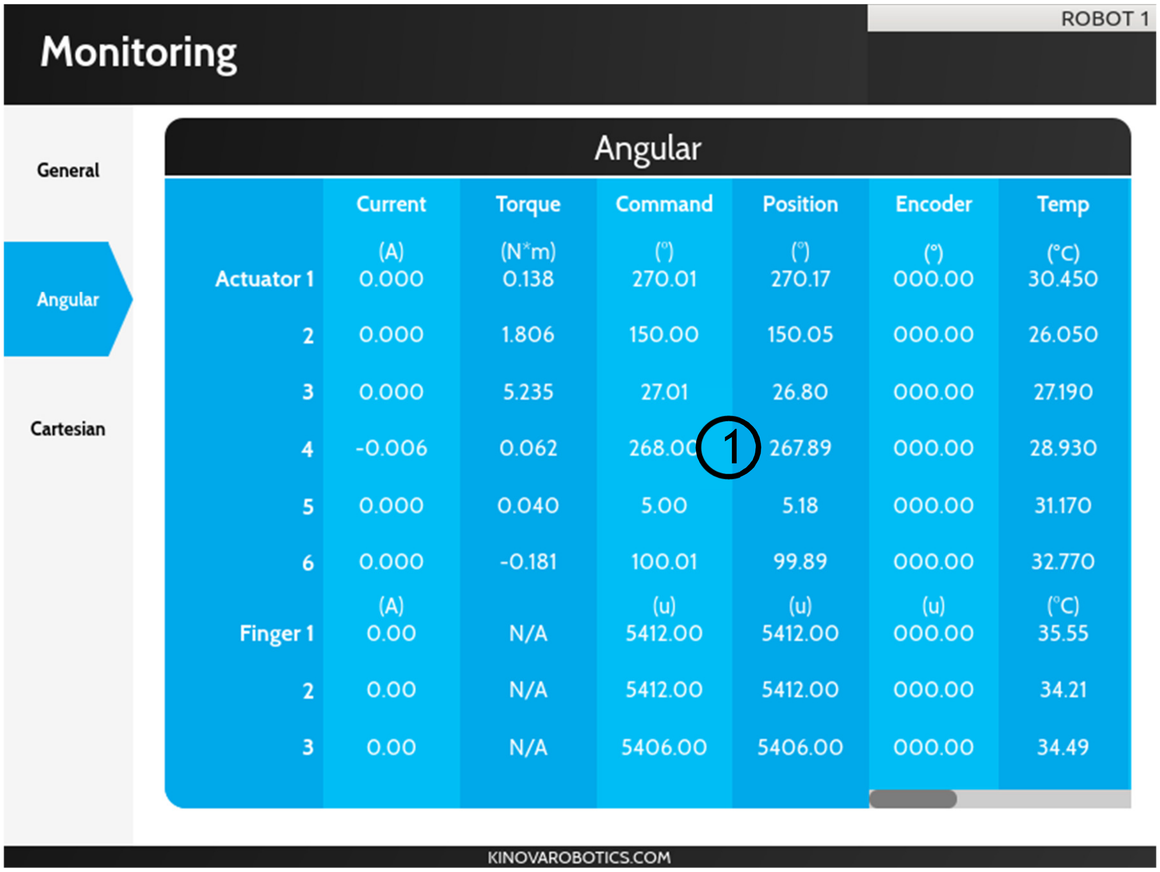
Monitoring

GENERAL



1	**System**	Displays general information stored in the robot.
2	**Peripheral list**	Lists all peripherals detected on the robot's communication bus. Each peripheral can be expanded to display its type, address, port and code version.

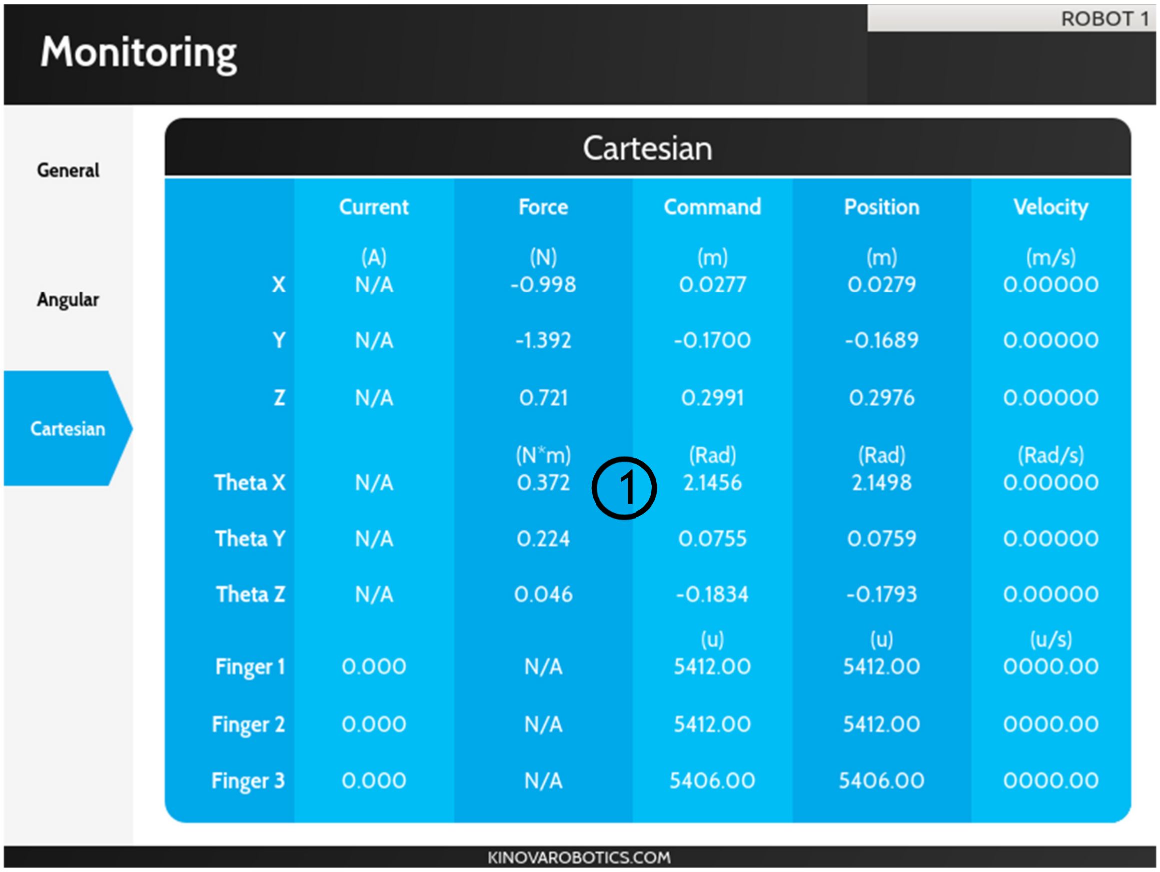
ANGULAR



1 **Angular**

Displays all the information on every actuator. It includes the current, torque, command, position, encoder value, temperature, velocity, acceleration along the X axis, acceleration along the Y axis and acceleration along the Z axis.

CARTESIAN

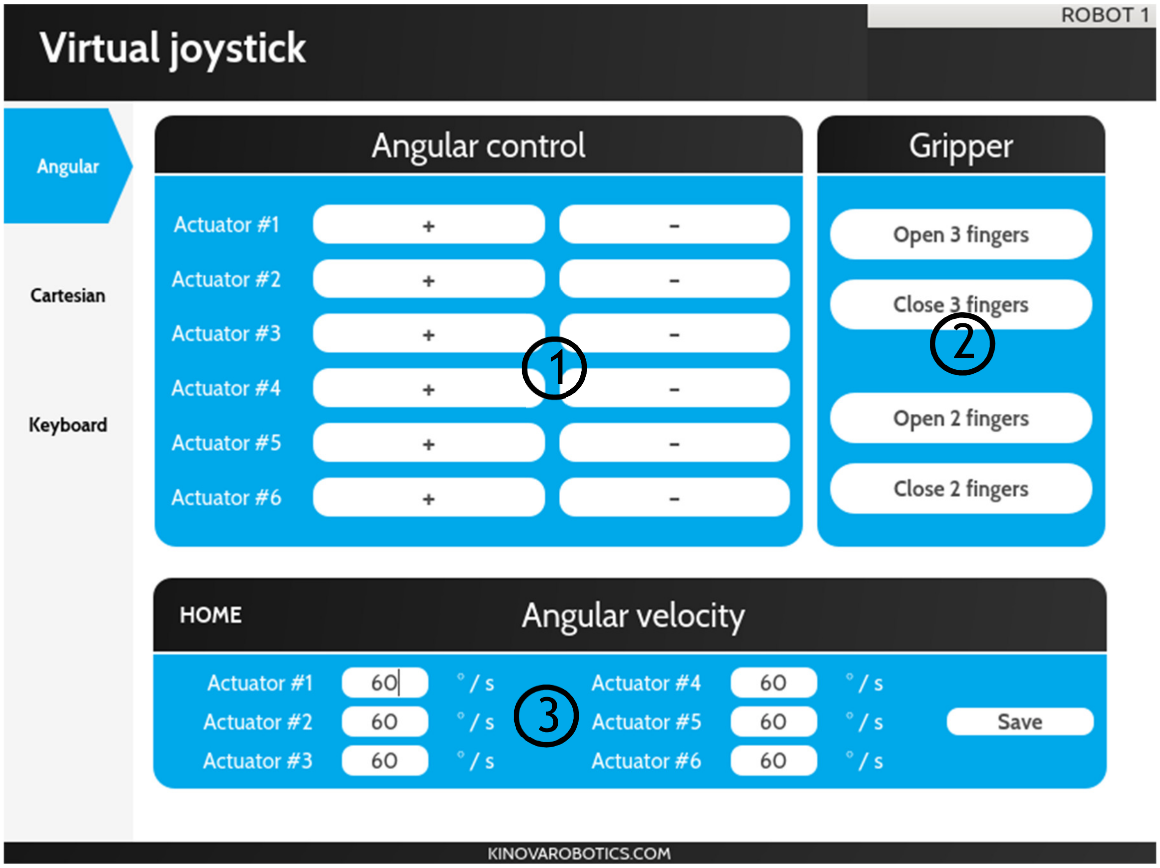


1 **Cartesian**

Displays all the information on the end effector's motion. It includes the force (gravity free), Cartesian command, Cartesian position and Cartesian velocity. Note that the Command's X, Y and Z fields and Position's X, Y and Z fields are expressed in the base reference frame. The Command's Theta X, Theta Y and Theta Z fields and Position's Theta X, Theta Y and Theta Z are Euler angles (XYZ convention) with respect to the base reference frame. The Velocity's X, Y and Z fields represent the end effector's translation velocities in the base reference frame. The Velocity's Theta X, Theta Y and Theta Z fields represent the end effector's rotation velocities in the effector reference frame.

Virtual joystick

ANGULAR



1 Angular control

Actuator X + Press and hold to move the actuator X counter clockwise where X is a number greater than 0.

Actuator X - Press and hold to move the actuator X clockwise where X is a number greater than 0.

2 Gripper

Open 3 fingers Press and hold to open the gripper's three fingers (only available on the 3 finger gripper)

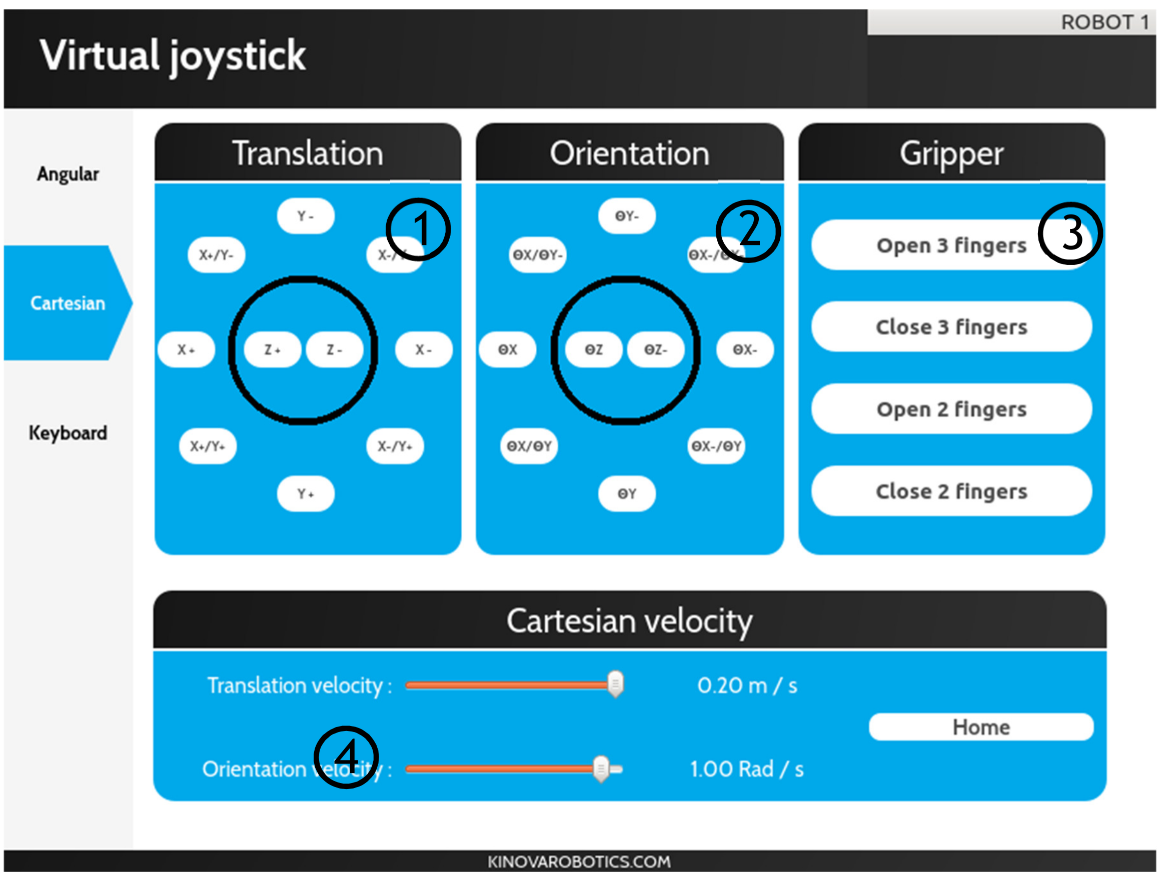
Close 3 fingers	Press and hold to close the gripper's three fingers (only available on the 3-finger gripper)
Open 2 fingers	Press and hold to open the gripper's thumb and index fingers.
Close 2 fingers	Press and hold to close the gripper's thumb and index fingers

3

Angular velocity

Text field	Set the velocity of a specific actuator.
Save	Send the new velocity configuration to the robot.

CARTESIAN



1

Translation

Button +	Press and hold to move the end effector along the positive axis described by the button.
Button -	Press and hold to move the end effector along the negative axis described by the button.

2

Orientation

Button +	Press and hold to move the end effector counter clockwise around the axis described by the button.
Button -	Press and hold to move the end effector clockwise around the axis described by the button.

3

Gripper

Open 3 fingers	Press and hold to open the gripper's three fingers (only available on the 3-finger gripper).
Close 3 fingers	Press and hold to close the gripper's three fingers (only available on the 3-finger gripper).
Open 2 fingers	Press and hold to open the gripper's thumb and index fingers.
Close 2 fingers	Press and hold to close the gripper's thumb and index fingers.

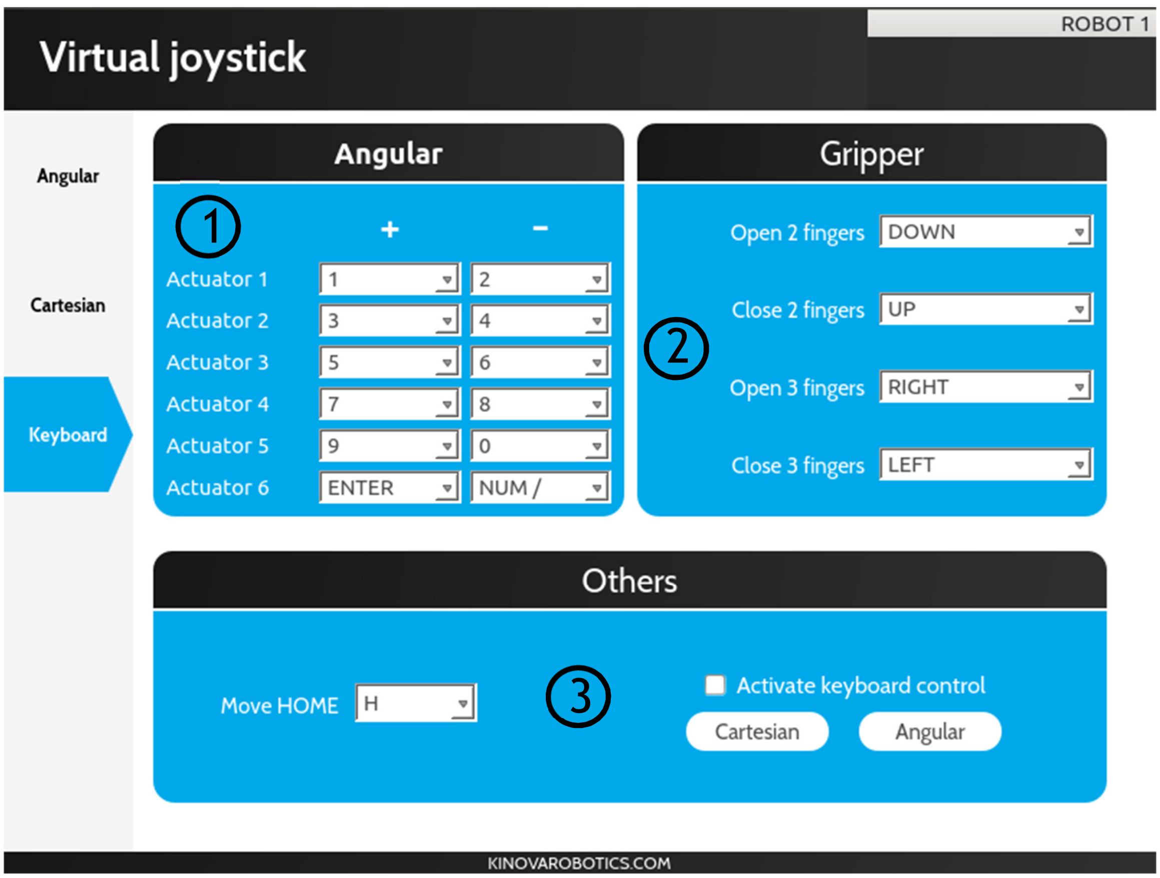
4

Cartesian velocity

Translation velocity Set the translation velocity of the end effector.

Orientation velocity Set the orientation velocity of the end effector.

KEYBOARD



1 **Control (Angular or Cartesian)**

Combo box Select a key that will be mapped with the specified movement. Note that this panel can be changed by pressing the angular or Cartesian button.

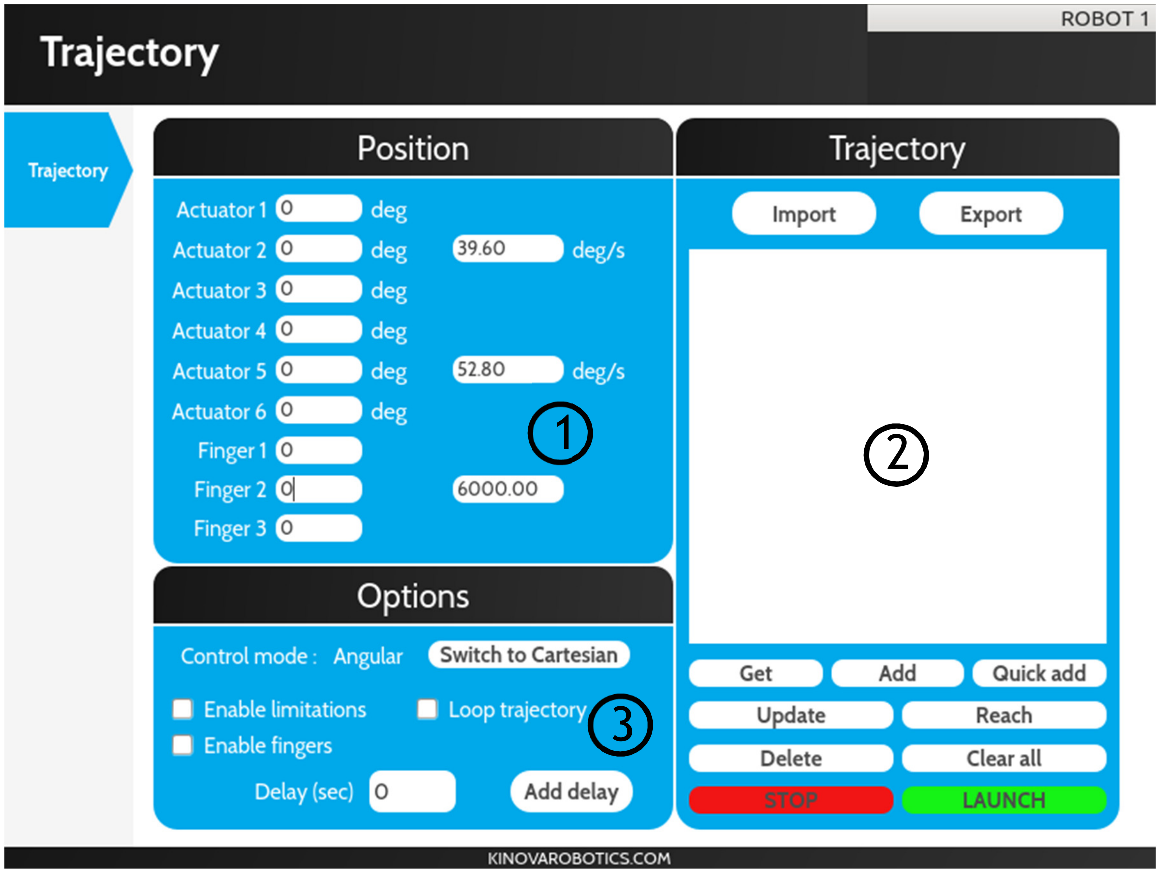
② **Gripper**

Combo box	Select a key that will be mapped with the specified gripper movement.

③ **Others**

Move HOME	Select a key that will be mapped with the Move HOME functionality.
Activate keyboard	Check to activate the keyboard control with the robot. Note that the robot's joystick will always have a higher control priority than the keyboard.
Cartesian	Press to switch the control panel to Cartesian.
Angular	Press to switch the control panel to Angular.

Trajectory planner



1 Position (Angular or Cartesian)

Left section Displays the current position or the position of a selected trajectory point.

Right section Displays the max velocity of the robot for the selected trajectory point.

2 Trajectory

Import Press to import a trajectory. The trajectory can be saved in a KTJ file on disk.

Export Press to export a trajectory on disk in a KTJ file.

Position list	Displays the list of positions contained in the trajectory. Each point can be selected and their data will be displayed on the position panel.
Get	Press to display the current robot's position on the position panel.
Add	Press to add a point in the list based on the information on the position panel.
Quick add	Press to execute a combination of a Get and Add.
Update	Press to update the selected point in the list with the information from the position panel.
Reach	Press to move the robot to the selected point in the list.
Delete	Press to delete the selected point in the list.
Clear all	Press to clear all the positions in the list.
Stop	Press to stop the robot's movement. It will also cancel any trajectory loops.
Launch	Press to execute the trajectory. If the Loop Trajectory check box is checked, the robot will repeat the trajectory until the stop button is pressed.

3 Options

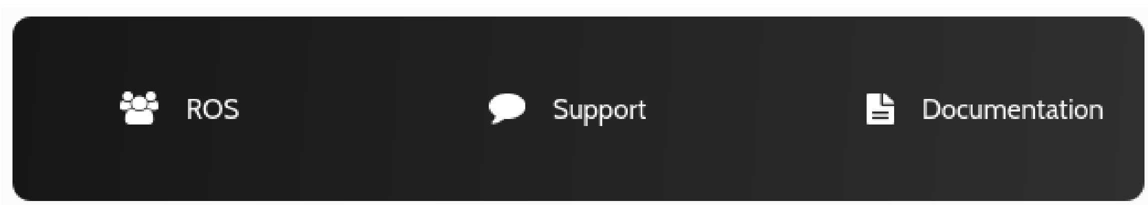
Control mode	Toggle to switch between Cartesian and Angular trajectory control.
Enable limitations	Check to enable maximum velocities limitations.

Enable finger Check to enable finger motion during trajectory (note: even if the fingers are enabled, they will not move if they weren't initialized. Fingers are initialized by opening them at their maximum range once).

Loop trajectory Check to execute trajectory in a loop once the Launch button is pressed

Delay Adds a delay before the robot starts moving to a given trajectory point.

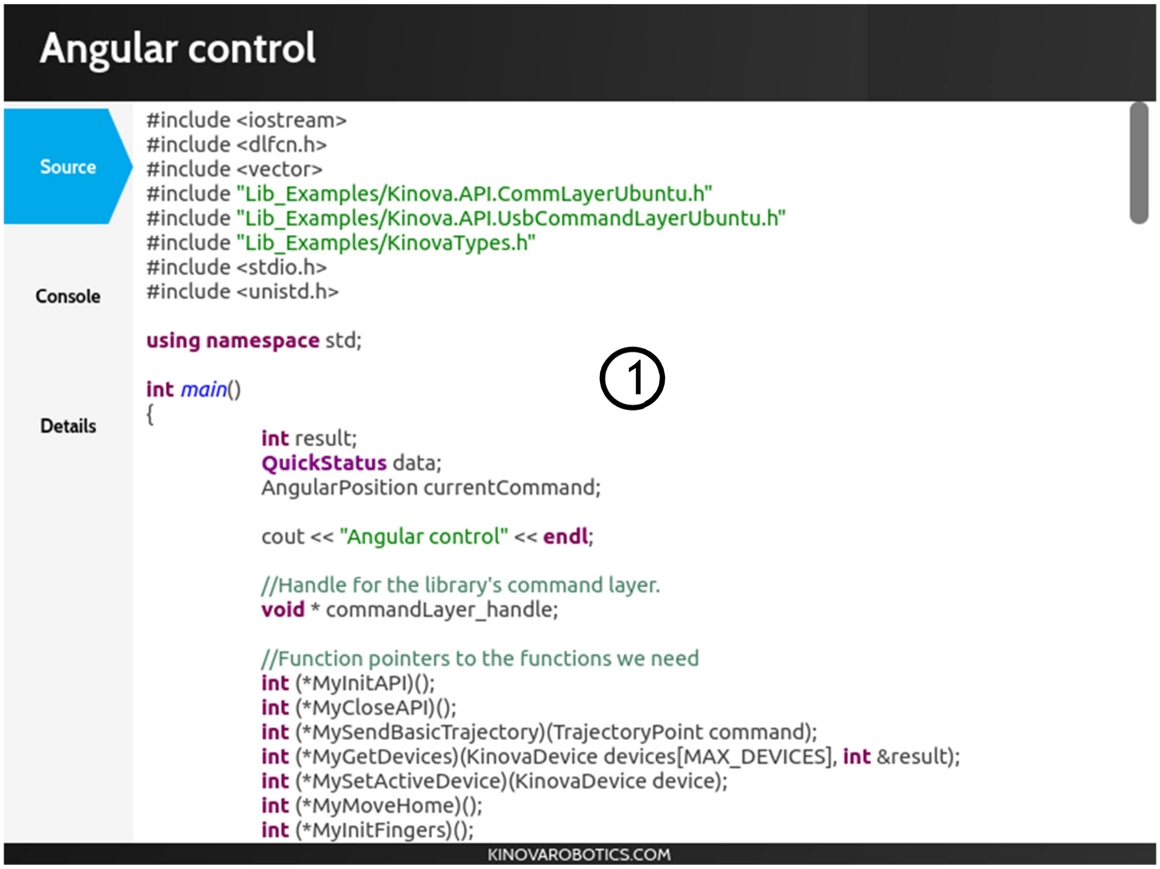
Resources



These are shortcuts to support elements found on Kinova's website.

Examples

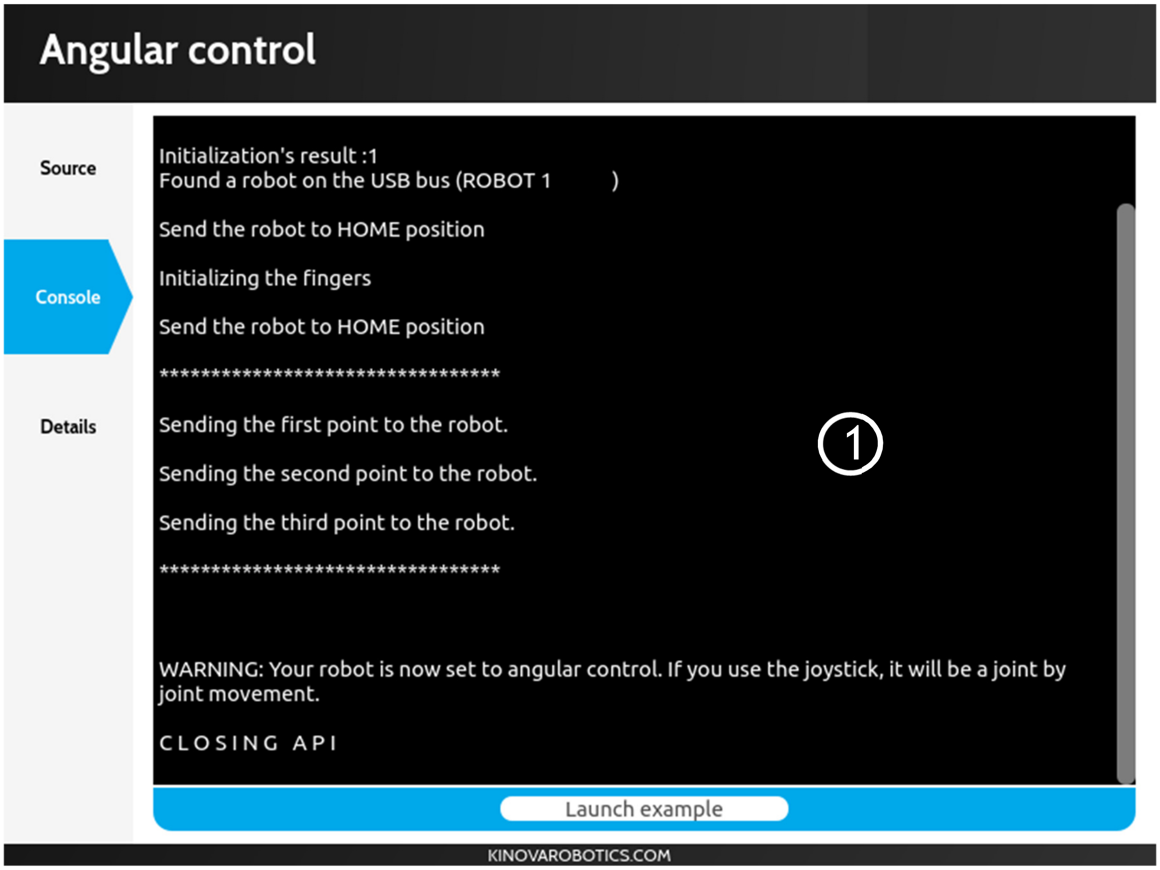
SOURCE



1 **Source**

Code	Displays the code that reflects the example.

CONSOLE

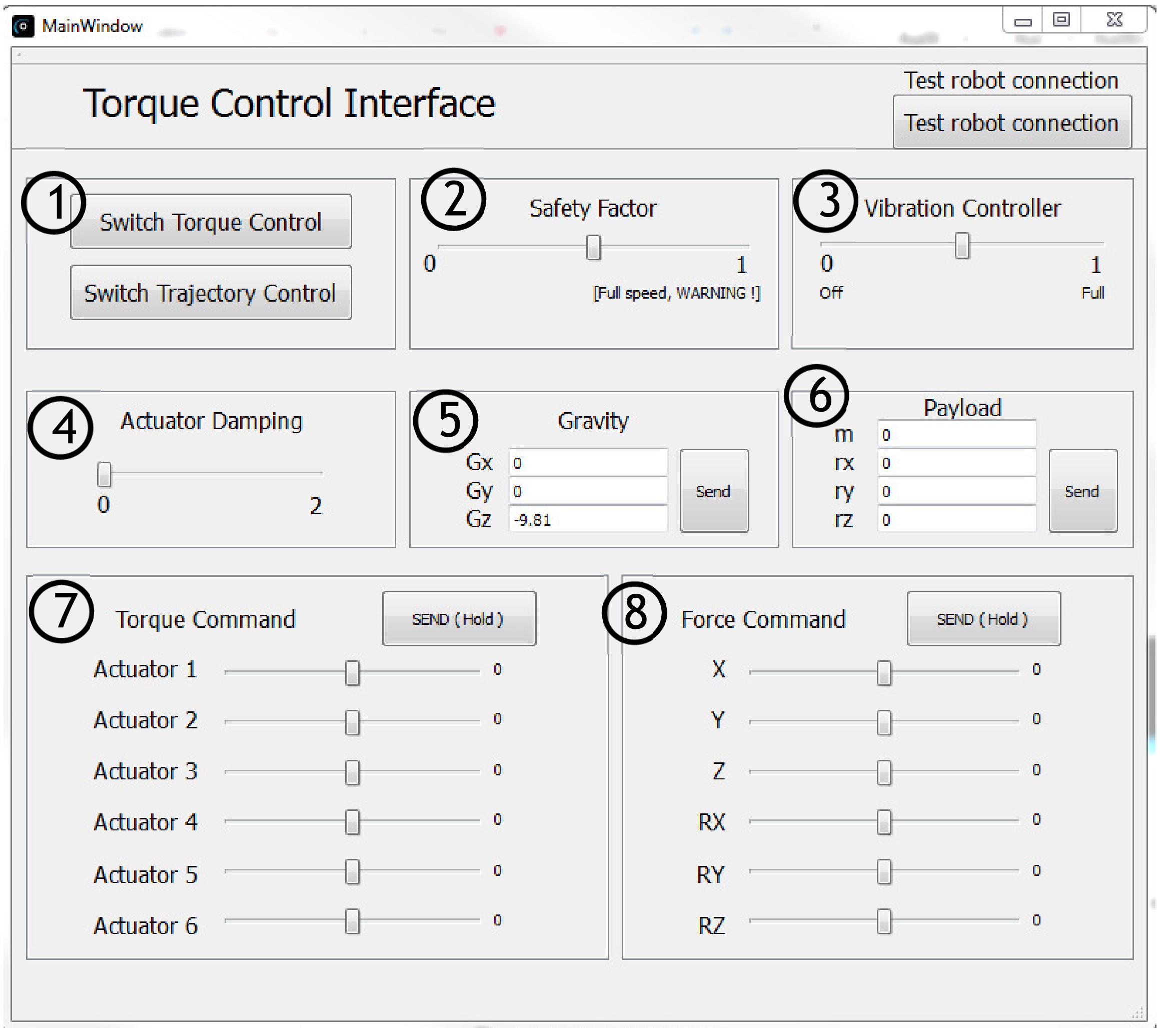


① Console

Output Displays the output of the example's execution in a console like window.

TORQUE CONSOLE

Main Window



1 Switch Torque and Trajectory

Switch Torque Control

Click to switch to direct torque control. When the robot is in torque control mode, you will be able to move it by hand with very little resistance. The robot also becomes unresponsive to joystick commands. Note that the robot might ‘refuse’ the switch to torque control. This means that the measured torques and the computed gravity torques are too different. Insure that the torque sensors are well calibrated (do a zero torque if needed), that the payload (when required) is appropriate, that the gravity vector is appropriate and that nothing is touching the robot. Generally, the robot's Home position is a good position to switch the control to torque mode.

Switch Trajectory Control	Click to switch to kinematics (position) control. When the robot is in kinematics control mode, you are not able to move it by hand and it is reactive to joystick inputs. Note that the robot should always be able to switch from torque mode to trajectory mode (it can have more trouble switching from trajectory mode to torque mode for the reasons given above). Also note that when the robot is switched from torque mode to trajectory mode, it automatically falls in Angular Kinematics control.

2 Safety factor

Safety factor	Slide the value from 0 (maximum safety: the robot switches from torque mode to trajectory mode as soon as the actuators' velocity is above a very low threshold) to 1 (minimal/no safety: the robot never switches)
⚠	Do not set Safety Factor to 1 unless you are sure the robot is in a collision-free environment. Ideally, validate the torques readings and the gravity-free torques before setting Safety Factor to 1, or else the robot could start moving very fast without being stopped.

3 Vibration controller

Vibration controller	Slide the value from 0 (no vibration controller) to 1 (maximum vibration controller). When vibration controller is activated, you should feel the vibration damped.

4 Actuator damping

Actuator damping	Slide the value from 0 (no damping) to 2 (max damping). When the damping is activated, you should feel more resistance moving the robot.

5 Gravity

Gravity vector	Enter the gravity vector orientation with respect to Kinova robot's base reference frame.

6 Payload

m	Enter the payload's mass
rx, ry, rz	Enter the payload's center of mass with respect to Kinova robot's effector reference frame.

7 Torque command

Actuator X	Specify a direct torque command on actuator X, where X is a number greater than 0. This command will be executed in torque mode as long as the button SEND (Hold) is held.
SEND (Hold)	Hold this button to send a direct torque command

8 Force command

X, Y, Z	Specify a force command to be applied at the end-effector. The force direction follows the base reference frame X, Y and Z axes direction. The force command will be executed in torque mode as long as the button SEND (Hold) is held.
RX, RY, RZ	Specify a torque command to be applied at the end-effector. The three torques are expressed with respect to the effector reference frame. The torque command will be executed in torque mode as long as the button SEND (Hold) is held.
SEND (Hold)	Hold this button to send a direct force command

CONTACTING SUPPORT

If you need help or have any questions about this product, this guide, or the information detailed in it, please contact a Kinova representative at:

- Support@KinovaRobotics.com

We value your comments!

To help us assist you more effectively with problem reports, the following information is required when contacting Kinova or your distributor support

- Product serial number
- Date/Time of the problem
- Environment where the problem occurred (per example 30° Celsius, raining, ...)
- Actions performed immediately before the problem occurred

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