Interbotix X-Series Arm w/ Standalone Raspberry Pi Quickstart Guide

Congrats on getting your new X-Series Interbotix Arm on a Raspberry Pi!

In just a matter of minutes, you will be ready to start your manipulation project. This quickstart will cover getting connected to your Arm as well as some troubleshooting steps if something goes wrong.

As an FYI, the password for the Pi is `interbotix`.

Hardware Requirements

To control an Interbotix X-Series Arm with a Raspberry Pi, you will need:
- 1x [X-Series Interbotix Robot Arm Kit](#) (including onboard U2D2 and X-Series power hub)
- 1x Raspberry Pi 4B (4GB RAM) Kit
- 1x Original Sony PS4 Controller

Dynamixel U2D2   Raspberry Pi 4B Kit   X-Series Motor Power Hub

Hardware Setup

There is not much required to get the Robot Arm up and running as most of the setup is done for you. Just make sure to do the following steps:
- Remove the Arm from its packaging and place it on a sturdy tabletop surface near an electrical outlet. To prevent the robot from potentially toppling during operation, secure it to a flat surface (via clamping or using the holes on the base's perimeter). At your own risk, you could instead place a small heavy bean bag on top of the acrylic plate by the base of the robot. Finally, make sure that there are no obstacles within the arm's workspace.
- Plug the 12V Arm Power Supply cable into an outlet and insert the barrel plug into the barrel jack on the X-series motor power hub (located under the see-through acrylic on the base of the robot). You should briefly see the LEDs on the Dynamixel motors flash red.

- Plug the micro-USB cable into the U2D2 (located under the see-through acrylic on the robot's base) and any USB port on the RPi.
- Connect a keyboard, mouse, and an HDMI monitor to the Pi. Then, plug the 5V Power Supply cable into an outlet and insert the other side into the Type-C USB port. Finally, flick the switch on the power cable.
- If you purchased the Pi Kit that includes the PS4 controller, the controller should already be paired. Jump to **Install Arm ROS Packages**.
- If you did not purchase the Pi Kit that includes the PS4 controller, continue to the next section as you will need to manually pair it.

PS4 Controller Setup

Getting a PS4 controller connected via Bluetooth to the Raspberry Pi is pretty straightforward. Once the Pi boots, click the *Bluetooth* icon on the top right of your Desktop, followed by *Setup New Device....* A window should pop up welcoming you to the 'Bluetooth device setup assistant.' Click the *Next* button. Then, press and hold the *Share* button on the PS4 controller. While holding the *Share* button, press and hold the *PS* button. After a few seconds, the triangular-shaped LED located between the *L2* and *R2* buttons should start rapidly flashing white (about twice a second) at which point you can let go.

On the computer, click the 'magnifying glass' icon on the lower left of the 'Device' window. Wait until you see 'Wireless Controller' pop up, select it, and click *Next* on the bottom right of the window. A message should pop up asking if you would like to *Pair Device* or *Proceed Without Pairing*. Select *Pair Device* and click *Next* on the bottom right of the screen.

A new message should now display asking you to either connect to *Human Interface Device Service (HID)* or *Don't Connect*. Select the *Human Interface Device Service (HID)* option and click *Next*. In the following screen, you should see a message either saying that the *Device added successfully, but failed to connect* or that the *Device added and connected successfully*. This is typical and you should just click *Close* on the bottom right of the screen.

If the message said that the device connected successfully, you will need to disconnect and reconnect the controller for the next step. To do that, hold down the *PS* button for about 10 seconds until the blue LED at the front of the controller turns off. Then, tap the *PS* button on the controller (no need to hold it down), and after waiting a few seconds, you should see the LED at the front turn blue. At this point, you should see a small popup on the top right of the screen titled 'Bluetooth Authentication'. Make sure to click the *Always Accept* option. This means that the computer will always pair with your PS4 controller when you tap the *PS* button.

Install Arm ROS Packages

To install the ROS packages, open a terminal (**Ctrl-Alt-T**), and type the following four commands in sequence (make sure to connect to the Internet first).

```
$ sudo apt install curl

$ curl
'https://raw.githubusercontent.com/Interbotix/interbotix_ros_manipulators/main/inter
botix_ros_xsarms/install/rpi4/xsarm_rpi4_install.sh' > xsarm_rpi4_install.sh

$ chmod +x xsarm_rpi4_install.sh

$ ./xsarm_rpi4_install.sh
```

After you run the last command, you will be prompted with a question asking about your robot model. Type the abbreviation on the right-hand side of the table below for your arm type.

Robot Type	Abbreviation
PincherX 100 Robot Arm	px100
PincherX 150 Robot Arm	px150
ReactorX 150 Robot Arm	rx150
ReactorX 200 Robot Arm	rx200
WidowX 200 Robot Arm	wx200
WidowX 250 Robot Arm	wx250
WidowX 250 6DOF Robot Arm	wx250s
ViperX 250 Robot Arm	vx250
ViperX 300 Robot Arm	vx300
ViperX 300 6DOF Robot Arm	vx300s
Mobile PincherX 100 Robot Arm	mobile_px100
Mobile WidowX 200 Robot Arm	mobile_wx200
Mobile WidowX 250 6DOF Robot Arm	mobile_wx250s

You will also be asked if you would like the 'Joystick ROS package to run at system boot'. In explanation, this 'program' is what allows you to control the arm with the PS4 controller. By typing `y` or `yes`, the Pi will automatically start this program when turned on. By typing anything else, the Pi will not start the program. Instead, you will have to manually run the program yourself every time. As a recommendation, if you want a Plug N' Play solution, then say `yes`. If you want to do your own development on the Pi, then type `no`.

If you typed `no`, you can manually run the program by opening a terminal (by pressing **Ctrl+Alt+T)** and typing…

```
$ roslaunch interbotix_xsarm_joy xsarm_joy.launch robot_model:=<robot_model>
use_rviz:=false
```

where `<robot_model>` should be replaced with one of the model names in the table above. Note that the `use_rviz` parameter configures whether you'd like to see a virtual arm copy the same movements as the real arm. In general, we would recommend setting this to false on the Raspberry Pi to take the load off the processor.

If you typed `yes` and would like to disable that feature later on, open a terminal on the Pi and type `sudo systemctl disable xsarm_rpi4_boot.service`. However, if you just want to shut down the 'program' temporarily, but have it start again at the next boot, just type `sudo pkill ros` in the terminal. Note that this will cause the motors in the robot arm to torque off. So make sure the arm is in a 'resting' position before typing this command.

Once the installation procedure completes, restart the Pi. At this point, you can disconnect the mouse, monitor, and keyboard, and continue with the next section.

Connecting to the Robot Arm

After turning on the Pi, wait until you see the red LEDs on the U2D2 flash white. At this point, tap the PS button on the controller. Then wait until the white LED on the front of the controller turns to a solid blue (a few seconds). This means that the controller has successfully connected to the Pi over Bluetooth. Now go and have fun! Make sure to take a look at the guide below to get familiar with the button mappings.

PS3 & PS4 Button Mappings

Button	Action
START/OPTIONS	move the robot to its Home pose
SELECT/SHARE	move the robot to its Sleep pose
R2	rotate the 'waist' joint clockwise
L2	rotate the 'waist' joint counterclockwise
△	increase gripper pressure in 0.125 step increments (max is 1)
X	decrease gripper pressure in 0.125 step increments (min is 0)
O	open gripper
□	close gripper
D-pad Up	increase the control loop rate in 1 Hz step increments (max of 40)
D-pad Down	decrease the control loop rate in 1 Hz step increments (min of 10)
D-pad Left	'coarse' control - sets the control loop rate to a user-preset 'fast' rate
D-pad Right	'fine' control - sets the control loop rate to a user-preset 'slow' rate
Right stick Up/Down	increase/decrease pitch of the end-effector
Right stick Left/Right	increase/decrease roll of the end-effector
R3	reverses the Right stick Left/Right control
Left stick Up/Down	move the end-effector (defined at 'ee_gripper_link') vertically in Cartesian space
Left stick Left/Right	move the end-effector (defined at 'ee_gripper_link') horizontally in Cartesian space
L3	reverses the Left stick Left/Right control
PS button	If torqued on, holding for 3 seconds will torque off the robot; if torqued off, tapping the button will torque on the robot

Port indicator

L2 button
L1 button

R2 button
R1 button

L

R

SONY

△ button
□ button
○ button
✕ button

Directional buttons

SELECT

START

Left stick
L3 button

Right stick
R3 button

SELECT button | START button

PS button

Troubleshooting

If your PS4 controller isn't working…

- Verify that the controller is paired with the Pi by confirming that the LED on the front of the controller is blue. If it's flashing white or not on, try repeating the **PS4 Controller Setup**. If the LED is a different color like red, green, or pink, that means your controller is paired with the Pi but connected to the wrong port. Most likely, this is because another controller is already paired with the Pi.
- Make sure that your controller is charged.
- Restart the Pi and try again.

Your monitor is not displaying anything…

- By default, if the Pi does not detect a monitor plugged in at boot, it will not display anything, even if the monitor is plugged in later. To use the monitor, make sure it's plugged into the Pi before turning the Pi on.

Other Info

If you purchased a Pi Kit from us and would like to work with it in a headless state, create a hotspot on your personal computer called 'master-hotspot' without requiring a password. The Pi is configured to automatically connect to this network when it's available.

To review the software and/or look at other questions customers have asked, please take a look at our GitHub page: https://github.com/Interbotix/interbotix_ros_manipulators. If you need assistance, feel free to contact us at trsupport@trossenrobotics.com. For other robotic kits, check out our website at https://www.trossenrobotics.com.

That's all! Have fun and good luck!

- From the InterbotiX Team