NIRYO

HUMAN - MOTION - ROBOT

VISION SET

USER MANUAL

V1

INTRODUCTION

This manual provides a general overview of Niryo's Vision Set and describes in detail how to control and use the product.

Niryo's Vision Set has been developed to allow the Niryo One to use its camera for dealing with its environment. This module can be used with:

- A prerecorded sequence which will be run by pressing the Niryo One's top button,
- A Blockly script written on Niryo Studio,
- A TCP script, which allows to access more functions than Blockly, to control the robot using vision,
- An image processing script written by the user.

Prerequisites

- Software Niryo One Version ≥ 2.3 (this version is installed on every Niryo One bought from the 30/06/2020)
- Niryo One Studio Version ≥ 2.3

If you do not have the recommended versions, you can refer to those tutorials:

- Update Niryo One Studio (https://niryo.com/docs/niryo-one/update-your-robot/update-niryo-one-studio/)
- Update the Raspberry Pi 3B image (https://niryo.com/docs/niryo-one/update-your-robot/update-raspberry-pi-image/)

Kit Overview

Part	Quantity	Description
Camera	x1	Niryo camera
Wrist Module	X1	Useful if you received your Niryo One before the 30/06/2020.
USB Cable	x1	PH-4 to USB 1m, connects the Camera to the Niryo One
Scratch	x2	Allows to attach the cable to the robotic arm
Calibration tip	x1	End effector used for workspace calibration
Upgraded Gripper jaw	x2	To replace the Standard Gripper jaws
Squared Container	X3	Handable 3D squares that can be used as containers for the circles

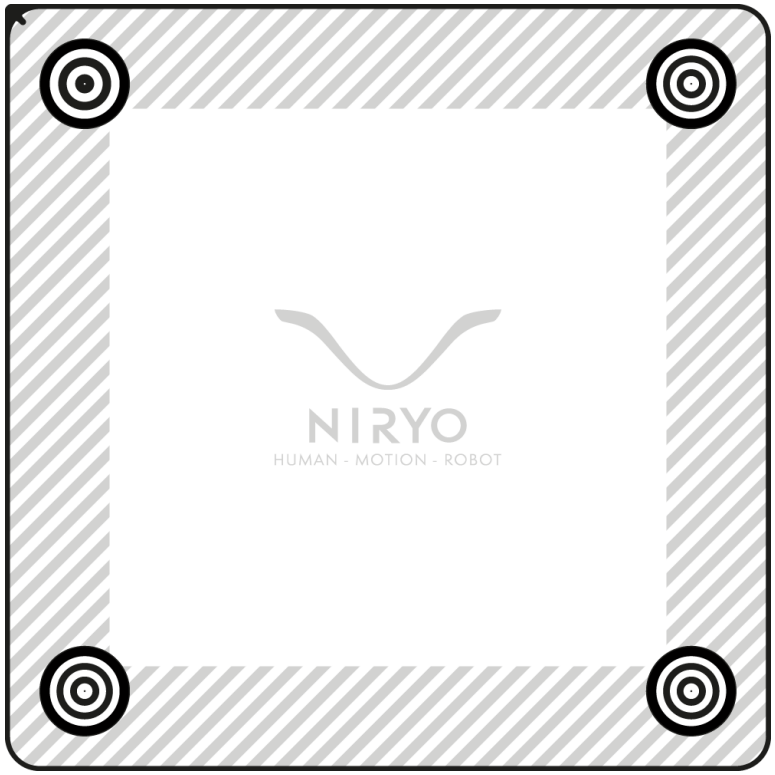
Circles	X3	Handable 3D circles that can be placed in the squared containers
Workspace board	x1	A repositionable printed workspace board
Workspace support	x1	Allows to set the workspace board
Mechanical Connector	x1	Which is composed of an aluminum base for the Niryo One and links to connect the workspace support as well as the Conveyor Belt

HOW THE VISION SET WORKS

Workspaces

The Vision Set uses a 2D camera to detect objects and calculate their positions in space. This detection allows to trigger actions of your choice.

To allow such functions with a 2D camera, we developed a system based on landmarks that define workspaces in 3 dimensions (the third dimension being the height, taking the height of the landmarks as origin).



For each Vision action related to Vision, the camera will give a relative position in the workspace reference that the robot will translate in its own reference. Please note that any action related to Vision will need to be done in a workspace.

Conditions

To use the Vision related functions, two conditions are required:

- Workspace's landmarks positions are set and mechanically fixed (more information about the calibration page 9),
- The landmarks delimiting the workspace are visible (objects too close to the landmarks could make them not entirely visible by the camera, and the tool used at the end of the arm can reduce the visual field of the camera).

Please note that these two conditions need to be met to allow the Vision related operations.

SETUP

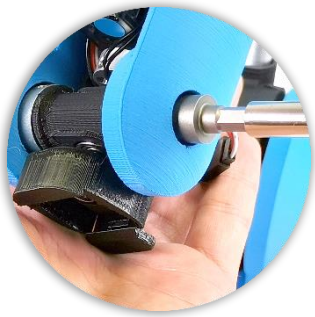
Hardware

The Vision wrist

If you received your Niryo One before the 30/06/2020, please first replace its wrist by the upgraded one provided in the Vision Set:

Remove the 4 screws of the motor

Remove the two screws of the wrist



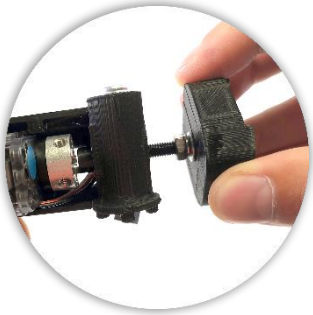
Remove the nut

Take the motor off

Remove the screw

Disconnect the motor

Remove the two screws

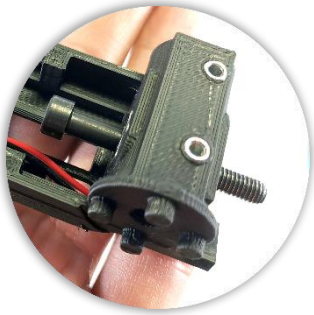


Pull the connector to free the motor

Remove the two screws

Remove the nut and the screw

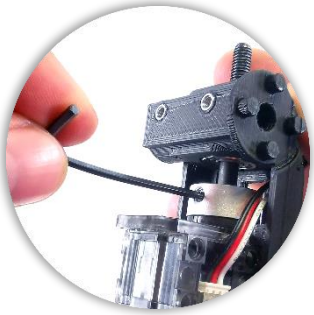
On the new wrist, put the cable through the hole



Put the screw in the wrist

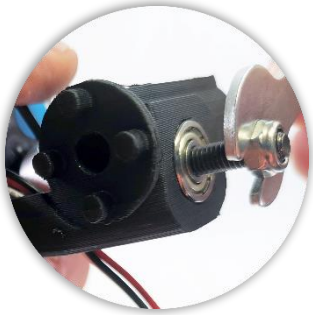
Plug the motor and push the screw into it

Align the strokes of the motor. Keep the alignment until the end of the process

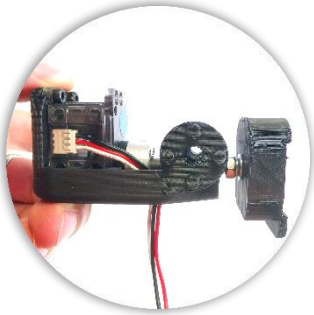


Add the two screws

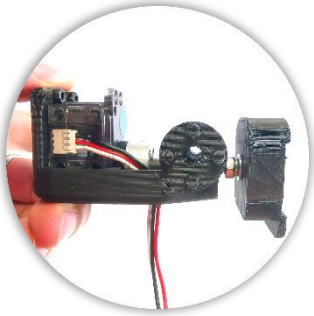
Put the two screws of the top of the motor



Add the nut, tighten it, and add the washer



Screw the connector in until the screw reaches the surface of the other side

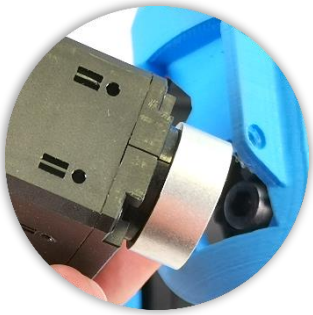


Align the connector as shown and unscrew the nut until everything is secured

Connect the motor as shown

Put the screw in the wrist

Screw the nut



Align the strokes of the motor

Put the motor on the wrist and add the four screws

Lock the system with two screws

On every Niryo One, position the camera on the wrist, align the screw holes of the two parts and add the screws.

Then, connect the camera to one of the USB ports of the robot and attach the cable to the arm with the provided scratches.

The workspace

We designed for Niryo One's ecosystem a **Mechanical Connector** that is composed of an aluminum base for the Niryo One and two bridges to connect a Workspace and a Conveyor Belt. This Mechanical Connector is included in the Vision Set.

Assembling this mechanical structure allows the workspace and/or the Conveyor Belt to always keep the same relative position to the Niryo One.

Align the aluminum rail and the stopper

Push the bridge into the rail

Screw until the stopper turns a quarter turn and blocks into the rail

Also, the provided **workspace** is printed on a specific support which uses a nano-suction technology that makes it **repositionable**. This workspace can be used on flat, regular, and clean surfaces. Please note that the workspace can be cleaned with few drops of water if needed. Keeping the workspace upside-down for a long time could damage it and reduce its gripping properties.

Software

Please start the robot and connect to it with Niryo One Studio.

Before using the Vision functions, you need to define the workspace(s) you will use. You can save as many workspaces as you want so if you are using an already saved workspace, you do not have to execute the following process.

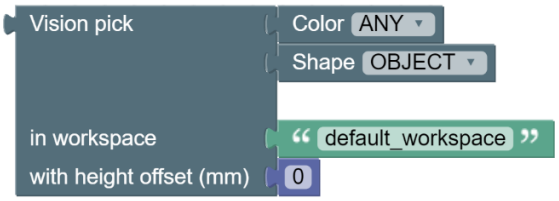
In Niryo One Studio's menu, open the Vision tab and click the button to add a new workspace. You will be guided, step by step, to set a workspace.

As you can use several workspaces in a same sequence, you can save as many workspaces as you need.

HOW TO USE THE VISION SET

On Niryo One Studio with Blockly

New blocks have been designed to be used with the Vision Set. It keeps the Niryo One Ecosystem easy to use with Niryo One Studio.

	Allows the user to choose a color among the list of available colors. This color will be used in the “Vision Pick” block and the “Is Object Detected” block.
	Allow the user to choose a shape among the list of available shapes. The selected shape will be used in the “Vision Pick” block and the “Is Object Detected” block.
	This block will make the Niryo One pick an object matching the color and shape selected. The picking move is typically: 1. Opening the gripper 2. Going over the object (5 cm) 3. Going down 4. Closing the gripper 5. Going back to 2. The pick will happen in the selected workspace (default_workspace in the example), and the “height offset” is the height at which the end effector will come for taking the object, based on the workspace height. Examples for height offset: 1. With the Vacuum Pump equipped, you can use the height of the object. 2. With the Standard Gripper equipped, it can be the half of the height of the object to take it at its middle. This block acts as a condition and so, returns a Boolean.
	This block returns a Boolean representing whether an object with the selected attributes (color and shape) is present in the workspace or not.

Please find below some use cases in Blockly. For each example, the sequence will be detailed step by step and you will have to set an observation position. To optimize this position, you can set the pitch value at 1.57. This will put the camera in the best position, front of the workspace, and you will have to adjust the other parameters depending on the gripper you are using.

Observation positions with the Standard Gripper

The following positions are given as examples and could depend on the gripper you use. Please make sure that the video stream shows the 4 landmarks.

1. Workspace in front of the robot

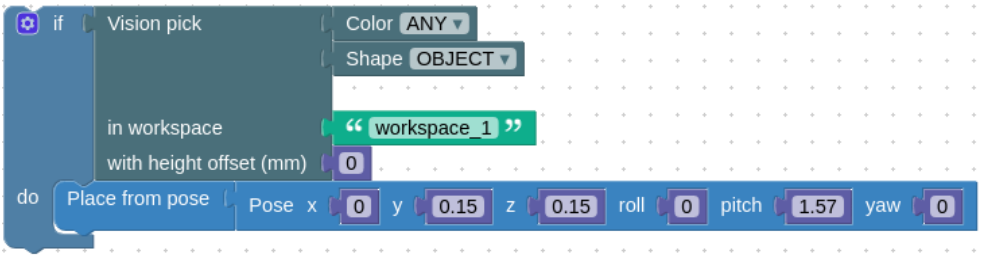
2. Workspace on the right of the robot

3. Workspace on the left of the robot

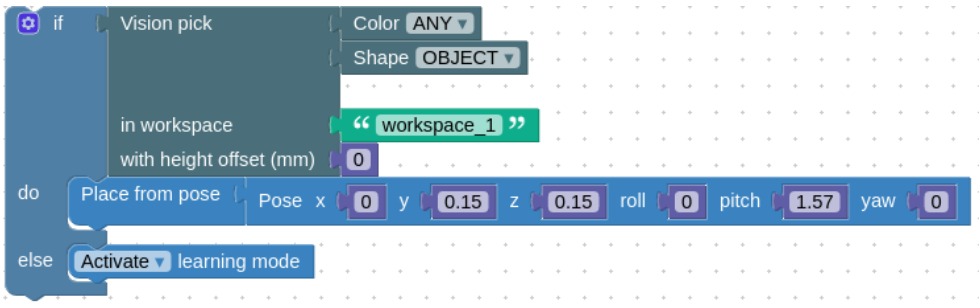
Simple Vision pick and place

Task
The Niryo One has to pick an object then place it.

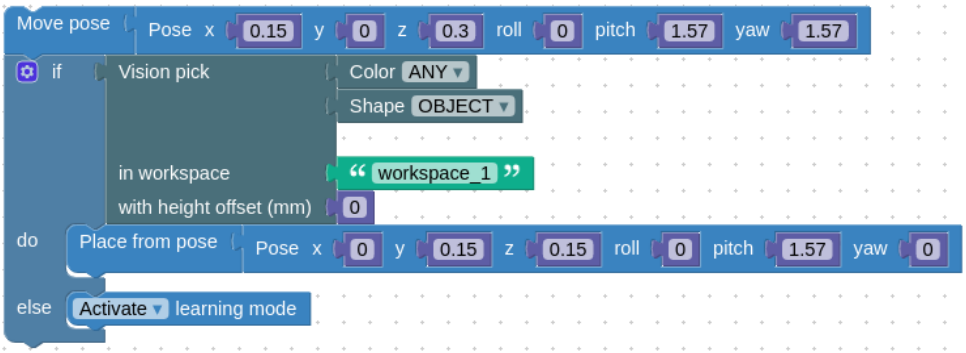
Explanation
To pick an object, you can use the “Vision Pick” block. It will return “True” if the action happened, so it can be put in a logic condition. So, if the action happens, we can place the picked object.



You can add an action in case the picking did not happen with “else”. In this case, the robot will turn on the learning mode.



So, a complete pick and place process could be resumed in this easy sequence, which defines an observation position and picks an object if there is a matching object in the “workspace_1” to place it elsewhere, or activates learning mode if no object matches the chosen attributes.



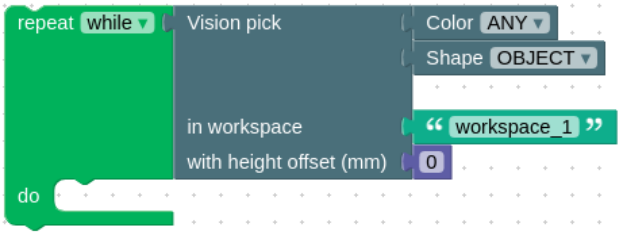
Object sorting with Vision pick and place

Task

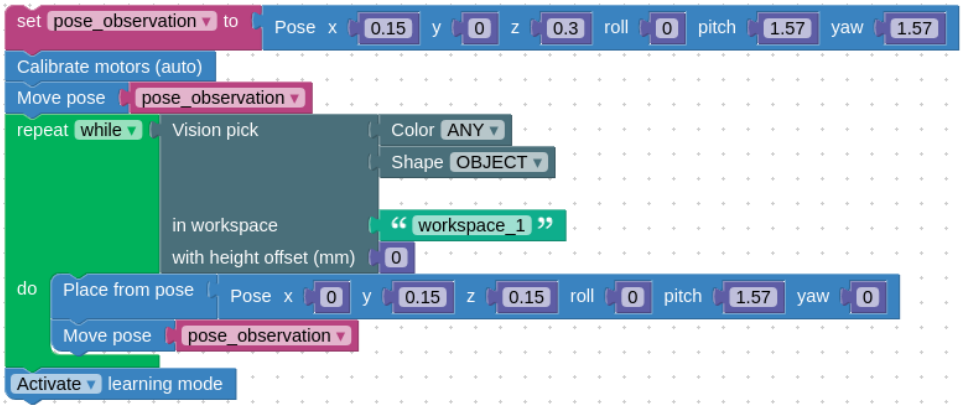
The Niryo One has to pick then place any object in the workspace.

Explanation

To make the Vision pick task, you can use the “Vision Pick” block, which will return “True” each time the action happens. By using a loop as a condition (here, “repeat while”), the robot will continue the process until it picked all the objects of the workspace.



Then, you need to add an action to place the object and move the robot to the observation position.



In this sequence, the Niryo One will calibrate its motors, pick all the objects of the workspace then activate the learning mode.

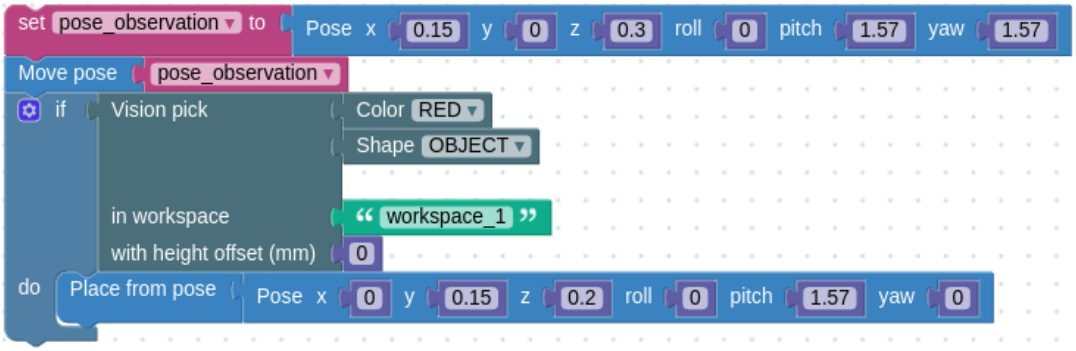
Multi-reference packaging with Vision pick and place

Task

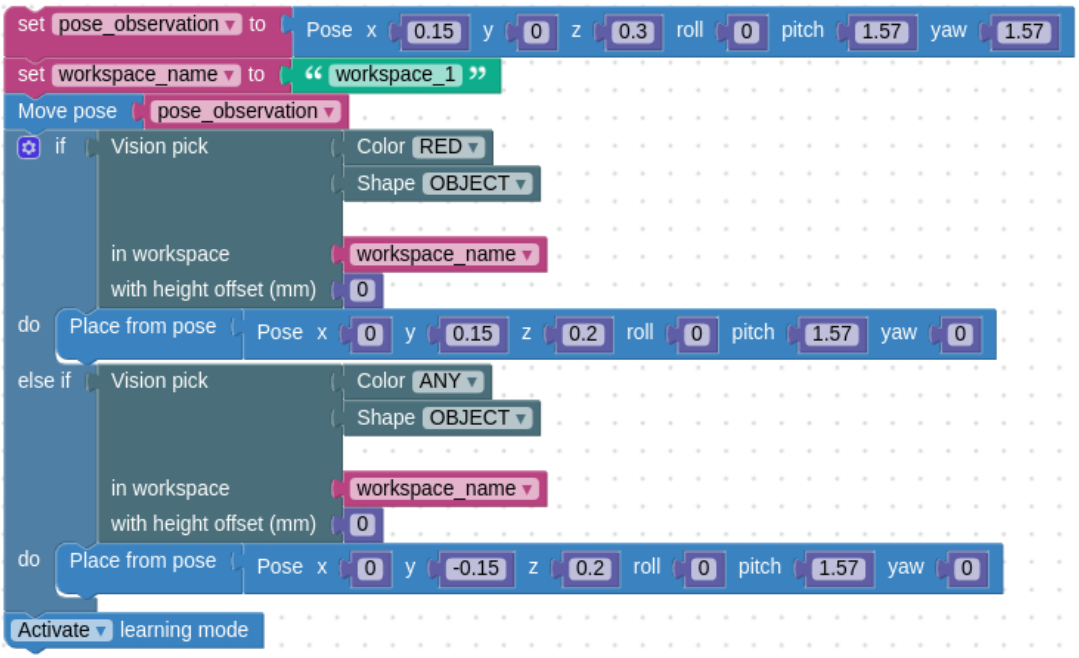
The Niryo One has to take all the objects from the workspace and place them at different positions depending on their attributes (the red objects in an area, the other ones in a different area).

Explanation

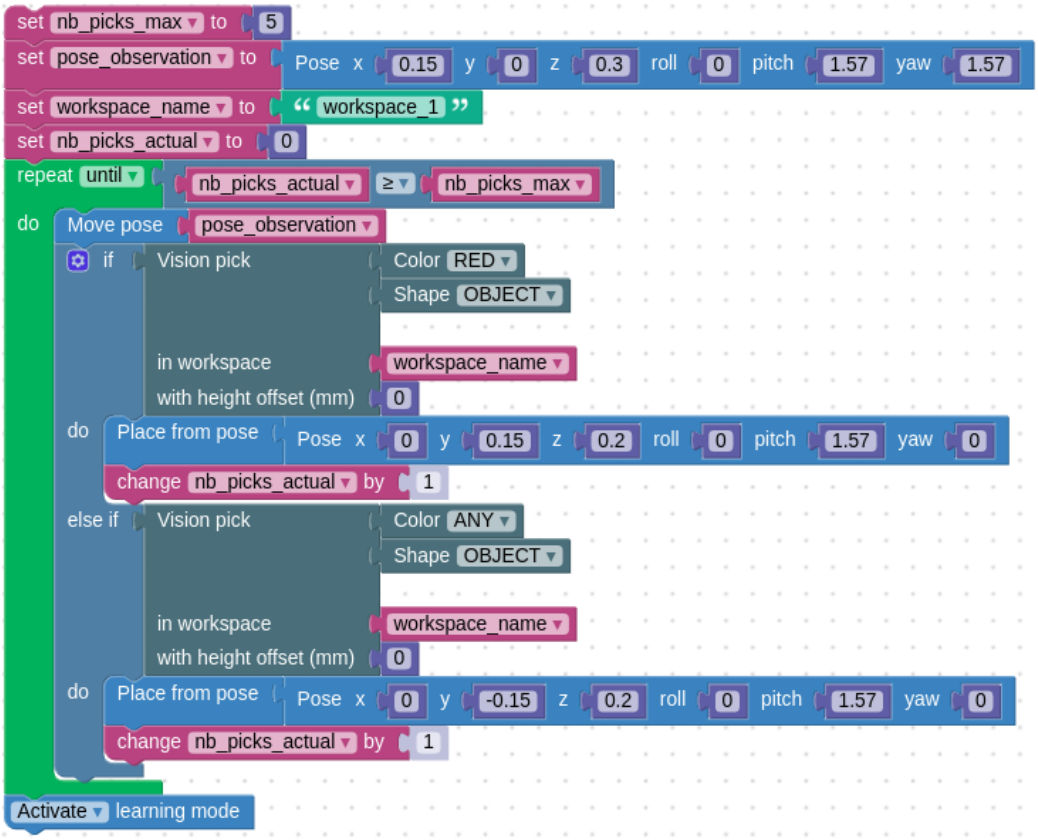
You will start the process by going to the observation position. Then, use the “Vision pick” block to interact with the red objects only. If the action happens, you can place the object in the area of your choice.



Then, you need to add an action that will be triggered if the pick did not happen, which means that there are no red objects anymore. You can use a “else if” condition:



With this program, the Niryo One will try to pick a red object, then place it in an area. If there is no red object in the workspace, the Niryo One will take another object to place it in another area. Now, you can use a loop to repeat this sequence.



Vision pick with the Conveyor Belt

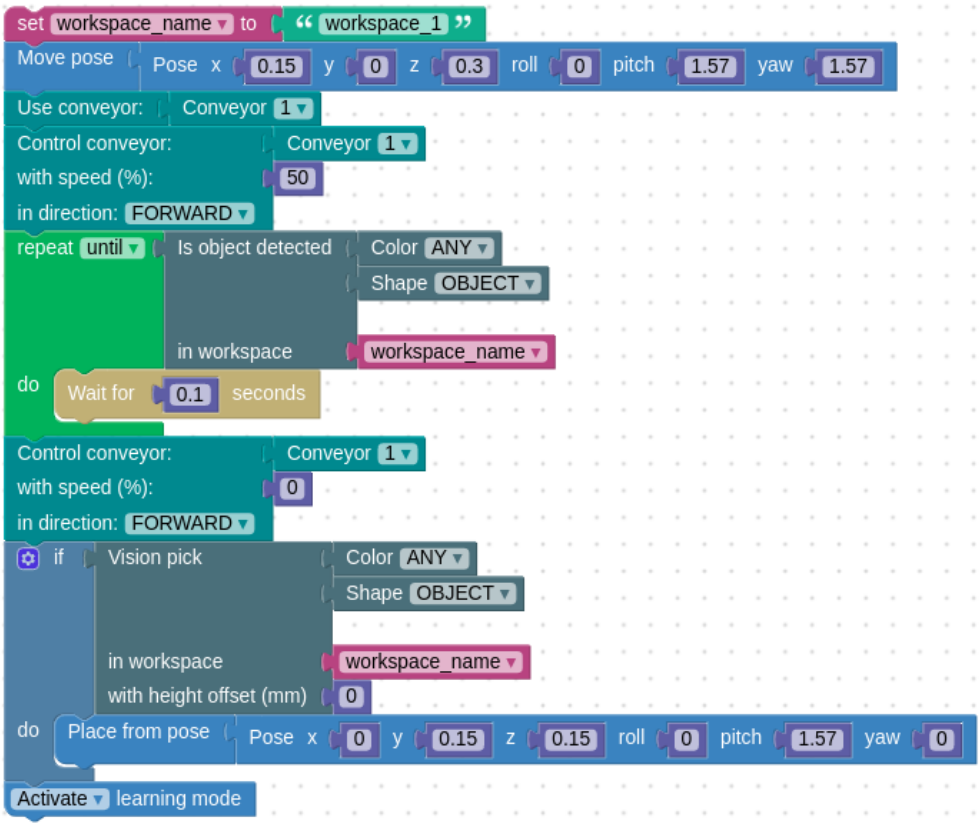
Task

The Niryo One has to take a number of objects from a workspace position on a Conveyor Belt, then place it in another area.

Explanation

With Blockly, the Niryo One is not able to pick a moving object, but it can control the Conveyor Belt if an object is in the workspace. So, you can:

1. Move the Niryo One to an observation position above the Conveyor Belt with “Move pose,
2. Turn on the Conveyor Belt with “Control Conveyor”,
3. Wait to see an object entering the workspace with “Repeat until object detected”
4. Stop the Conveyor with “Control Conveyor”
5. Pick the object and place it in the position of your choice with “Vision Pick”



With Python API

You can control the Niryo One using the Python API directly.

It will give you access to more functions than Blockly and you will be able to develop more complex processes.

Python API tutorial:
https://niryo.com/docs/niryo-one/developer-tutorials/use-the-niryo-one-python-api/

Detailed documentation:
https://github.com/NiryoRobotics/niryo_one_ros/tree/master/niryo_one_python_api

With TCP Server/Client

You can control the Niryo One using a TCP API.

It will give you access to more functions than Blockly and you will be able to develop more complex processes including image processing pipelines.

Detailed documentation:
https://niryo.com/documentation/tcp-python-api/

WARNINGS & TYPICAL ISSUES

Warnings

Before using the Vision Set, please make sure to:

- Take the lens protection off when you use the Vision Set, then replace it when you do not,
- Do not touch the lens,
- Be careful that the cable does not wrap around the Niryo One

FAQ

Q: The video streaming on Niryo Studio is totally black

A: Please check the camera and make sure you removed the protection of the lens, and that the cable is well plugged. Then, restart the stream on Niryo Studio.

Q: The video streaming on Niryo Studio froze

A: Please check the connection of the cable. If the robot is also frozen, please restart it. If not, deactivate and reactivate the stream in Niryo One Studio.

Q: My robot constantly misses the object when picking

A: First, make sure that your workspace is correctly set by clicking its landmarks in the Vision tab of Niryo One Studio's menu. Then, check if the Niryo One can see these landmarks by watching the stream. Make sure that the observation position let set the 4 landmarks. If you are using several workspaces, make sure that the Niryo One does not see any other landmark than the four of the workspace it is working with at the moment.

Q: My robot freezes when using the Vision Set. I cannot do anything anymore.

A: The Vision Set requires a good network quality to show a livestream. If you are using a Wi-Fi network, it may overload it, generating some latency between the commands and the robot reaction. You can disable the stream in Niryo One Studio by changing the tab to the 3D view, or connect your computer to the Niryo One via Ethernet (tutorial: https://niryo.com/docs/niryo-one/developer-tutorials/connect-to-niryo-one-via-ethernet-on-ubuntu/).