Practical Exercises 1: Introduction to Robotics

Objective:

In this practical exercise you should learn and apply the basic fundamentals in robotics. For this reason a simulation software is used: CoppeliaSim from Coppelia Robotics. There is a free **educational** version available.

Preparation:

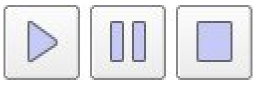
Download the current **educational** version of the software CoppeliaSim from the homepage of Coppelia Robotics GmbH, http://www.coppeliarobotics.com/

Task 1:

Start the program CoppeliaSim and load different so called “scenes” and start the simulation.

A simulation in CoppeliaSim can be started, paused and stopped with

[Menu bar --> Simulation --> Start/Pause/Stop simulation] or through the related toolbar buttons:



[Simulation start/pause/stop toolbar buttons]

Play around with the system, take a look into the CoppeliaSim user manual, which can be accessed by

[Menu bar --> Help --> Help Topics]

Task 2:

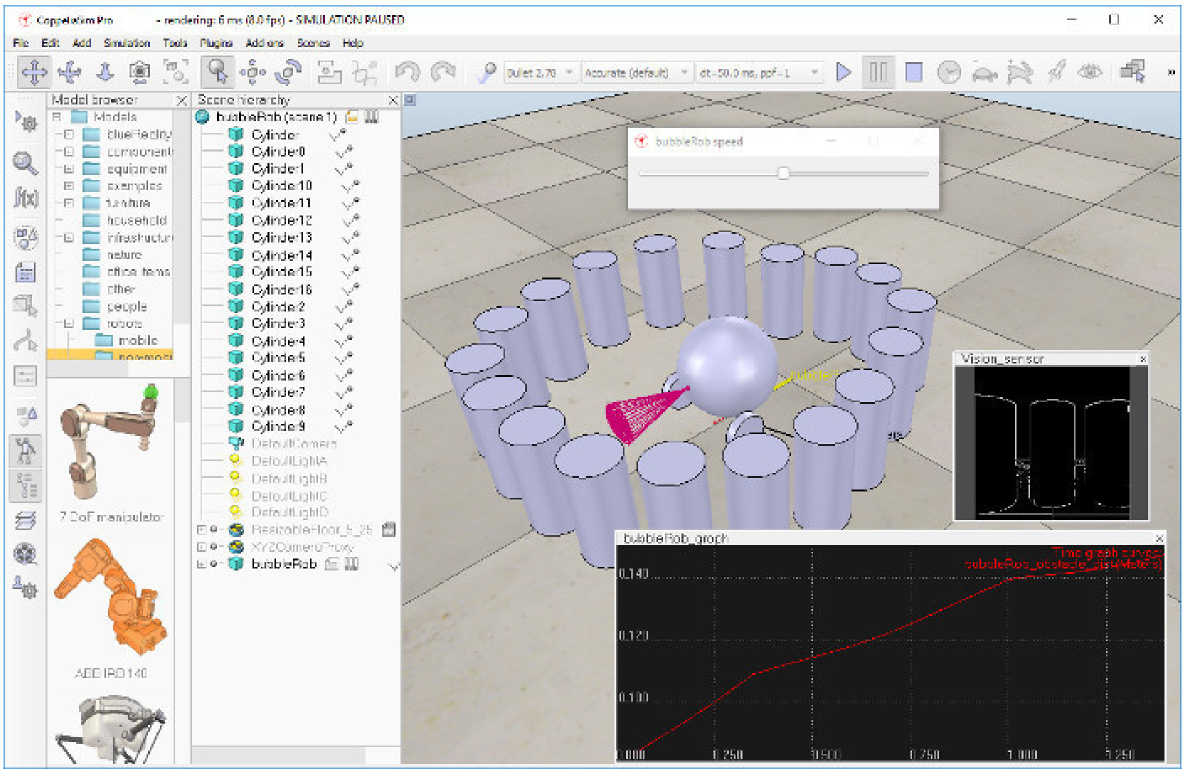
Implement a scene in CoppeliaSim, which is explained in the following BubbleRob tutorial. The scene consists of several obstacles and a two-wheeled robot with a vision and a proximity sensor.

Try to understand the script code at the end, which is written in Lua programming language.
Do several adjustments in the scene by trying things out (changing colors, behaviours, ..). Use the remote API as described, to control the robot through Python.

Report: none

BubbleRob tutorial

This tutorial will try to introduce quite many CoppeliaSim functionalities while designing the simple mobile robot *BubbleRob*. The CoppeliaSim scene file related to this tutorial is located in *scenes/tutorials/BubbleRob*. Following figure illustrates the simulation scene that we will design:



CoppeliaSim Pro - rendering: 6 ms (8.0 fps) - SIMULATION PAUSED
File Edit Add Simulation Tools Plugins Add-ons Scenes Help
Model browser
Scene hierarchy
bubbleRob speed
Vision_sensor
bubbleRob_graph
7 DoF manipulator
ABB IRB 140

Since this tutorial will fly over many different aspects, make sure to also have a look at the other tutorials, mainly the tutorial about building a simulation model. First of all, freshly start CoppeliaSim. The simulator displays a default scene. We will start with the body of *BubbleRob*.

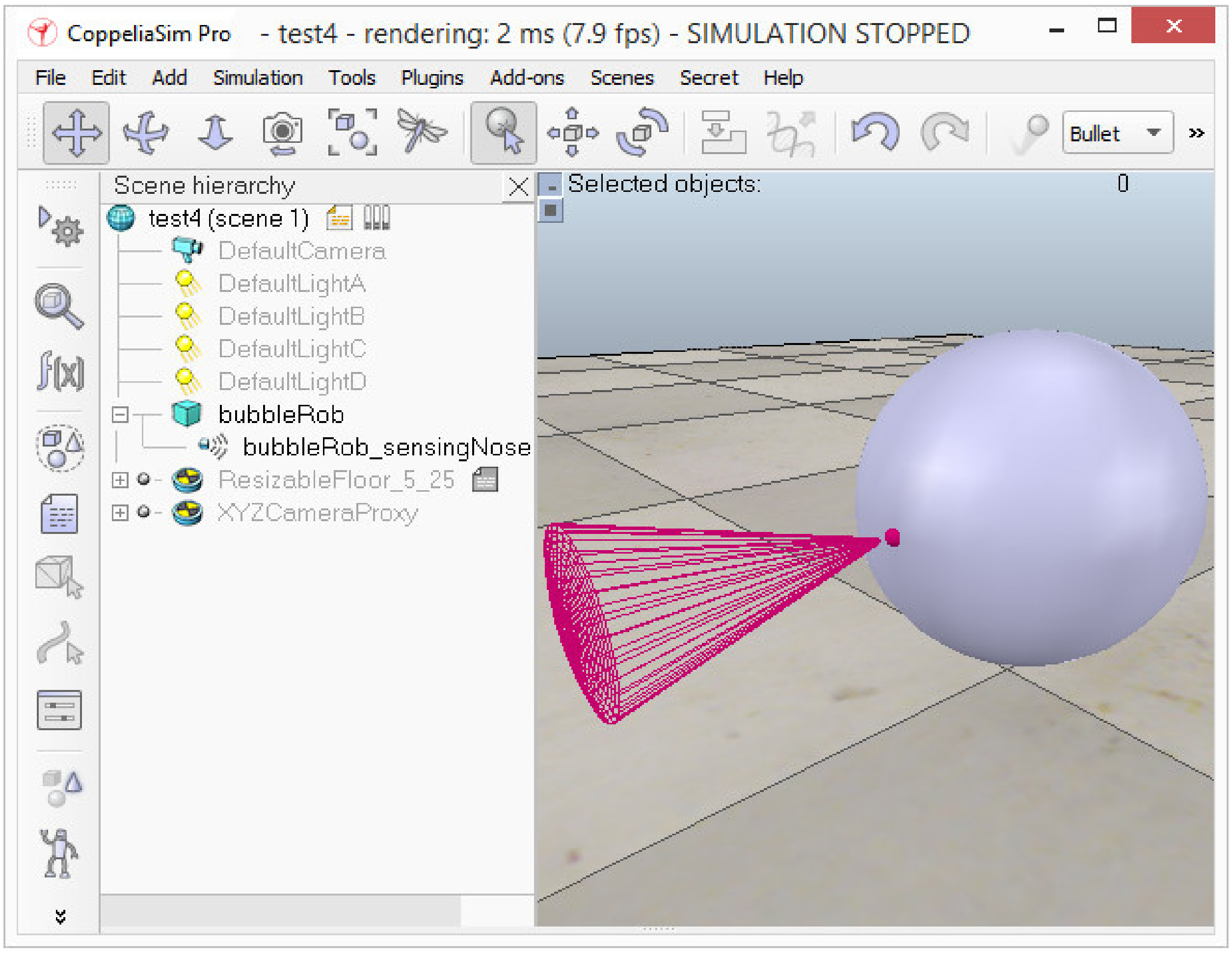
We add a primitive sphere of diameter 0.2 to the scene with [Menu bar --> Add --> Primitive shape --> Sphere]. We adjust the **X-size** item to 0.2, then click **OK**. The created sphere will appear in the visibility layer 1 by default, and be dynamic and respondable (since we kept the item **Create dynamic and respondable shape** enabled). This means that *BubbleRob's* body will be falling and able to react to collisions with other respondable shapes (i.e. simulated by the physics engine). We can see this is the shape dynamics properties: items **Body is respondable** and **Body is dynamic** are enabled. We start the simulation (via the toolbar button, or by pressing <control-space> in the scene window), and copy-and-paste the created sphere (with [Menu bar --> Edit --> Copy selected objects] then [Menu bar --> Edit -> Paste buffer], or with <control-c> then <control-v>): the two spheres will react to collision and roll away. We stop the simulation: the duplicated sphere will automatically be removed. This default behaviour can be modified in the simulation dialog.

We also want the *BubbleRob's* body to by usable by the other calculation modules (e.g. distance calculation). For that reason, we enable **Collidable**, **Measurable**, **Renderable** and **Detectable** in the object common properties for that shape, if not already enabled. If we wanted, we could now also change the visual appearance of our sphere in the shape properties.

Now we open the position dialog on the **translation** tab, select the sphere representing *BubbleRob's* body, and enter 0.02 for **Along Z**. We make sure that the **Relative to**-item is set to **World**. Then we click **Translate selection**. This translates all selected objects by 2 cm along the absolute Z-axis, and effectively lifted our sphere a little bit. In the scene hierarchy, we double-click the sphere's name, so that we can edit its name. We enter *bubbleRob* and press enter.

Next we will add a proximity sensor so that *BubbleRob* knows when it is approaching obstacles: we select [Menu bar --> Add --> Proximity sensor --> Cone type]. In the orientation dialog on the **orientation** tab, we enter 90 for **Around Y** and for **Around Z**, then click **Rotate selection**. In the position dialog, on the **position** tab, we enter 0.1 for **X-coord.** and 0.12 for **Z-coord.** The proximity sensor is now correctly positioned relative to *BubbleRob's* body. We double-click the proximity sensor's icon in the scene hierarchy to open its properties dialog. We click **Show volume parameter** to open the proximity sensor volume dialog. We adjust items **Offset** to 0.005, **Angle** to 30 and **Range** to 0.15. Then, in the proximity sensor properties, we click **Show detection parameters**. This opens the proximity sensor detection parameter dialog. We uncheck item **Don't allow detections if distance smaller than** then close that dialog again. In the scene hierarchy, we double-click the proximity sensor's name, so that we can edit its name. We enter *bubbleRob_sensingNose* and press enter.

We select *bubbleRob_sensingNose*, then control-select *bubbleRob*, then click [Menu bar --> Edit --> Make last selected object parent]. This attaches the sensor to the body of the robot. We could also have dragged *bubbleRob_sensingNose* onto *bubbleRob* in the scene hierarchy. This is what we now have:

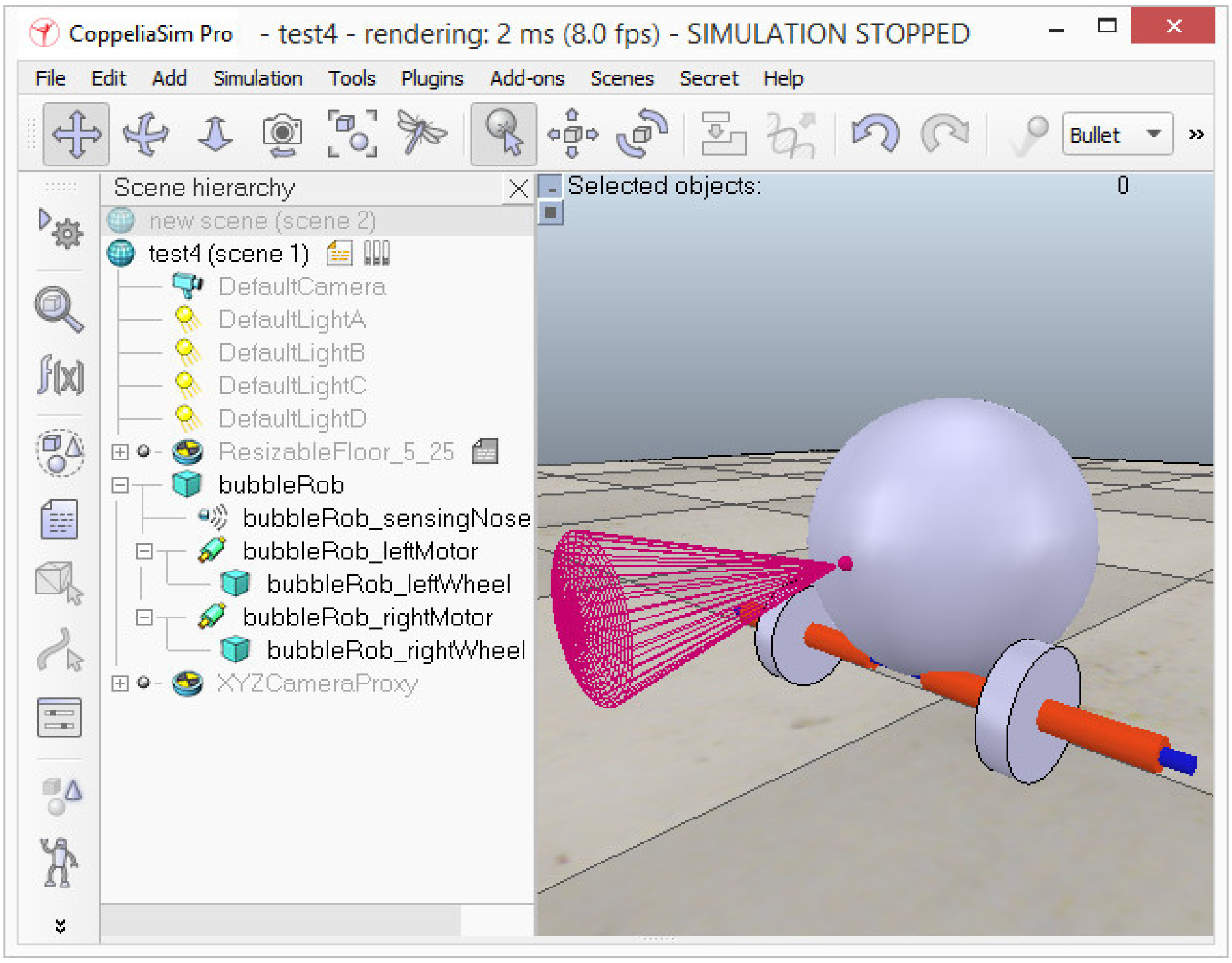


[Proximity sensor attached to *bubbleRob's* body]

Next we will take care of *BubbleRob's* wheels. We create a new scene with [Menu bar --> File --> New scene]. It is often very convenient to work across several scenes, in order to visualize and work only on specific elements. We add a pure primitive cylinder with dimensions (0.08,0.08,0.02). As for the body of *BubbleRob*, we enable Collidable, Measurable, Renderable and Detectable in the object common properties for that cylinder, if not already enabled. Then we set the cylinder's absolute position to (0.05,0.1,0.04) and its absolute orientation to (-90,0,0). We change the name to *bubbleRob_leftWheel*. We copy and paste the wheel, and set the absolute Y coordinate of the copy to -0.1. We rename the copy to *bubbleRob_rightWheel*. We select the two wheels, copy them, then switch back to scene 1, then paste the wheels.

We now need to add joints (or motors) for the wheels. We click [Menu bar --> Add --> Joint --> Revolute] to add a revolute joint to the scene. Most of the time, when adding a new object to the scene, the object will appear at the origin of the world. We Keep the joint selected, then control-select *bubbleRob_leftWheel*. In the position dialog, on the **position** tab, we click the **Apply to selection** button: this positioned the joint at the center of the left wheel. Then, in the orientation dialog, on the **orientation** tab, we do the same: this oriented the joint in the same way as the left wheel. We rename the joint to *bubbleRob_leftMotor*. We now double-click the joint's icon in the scene hierarchy to open the joint properties dialog. Then we click **Show dynamic parameters** to open the joint dynamics properties dialog. We **enable the**

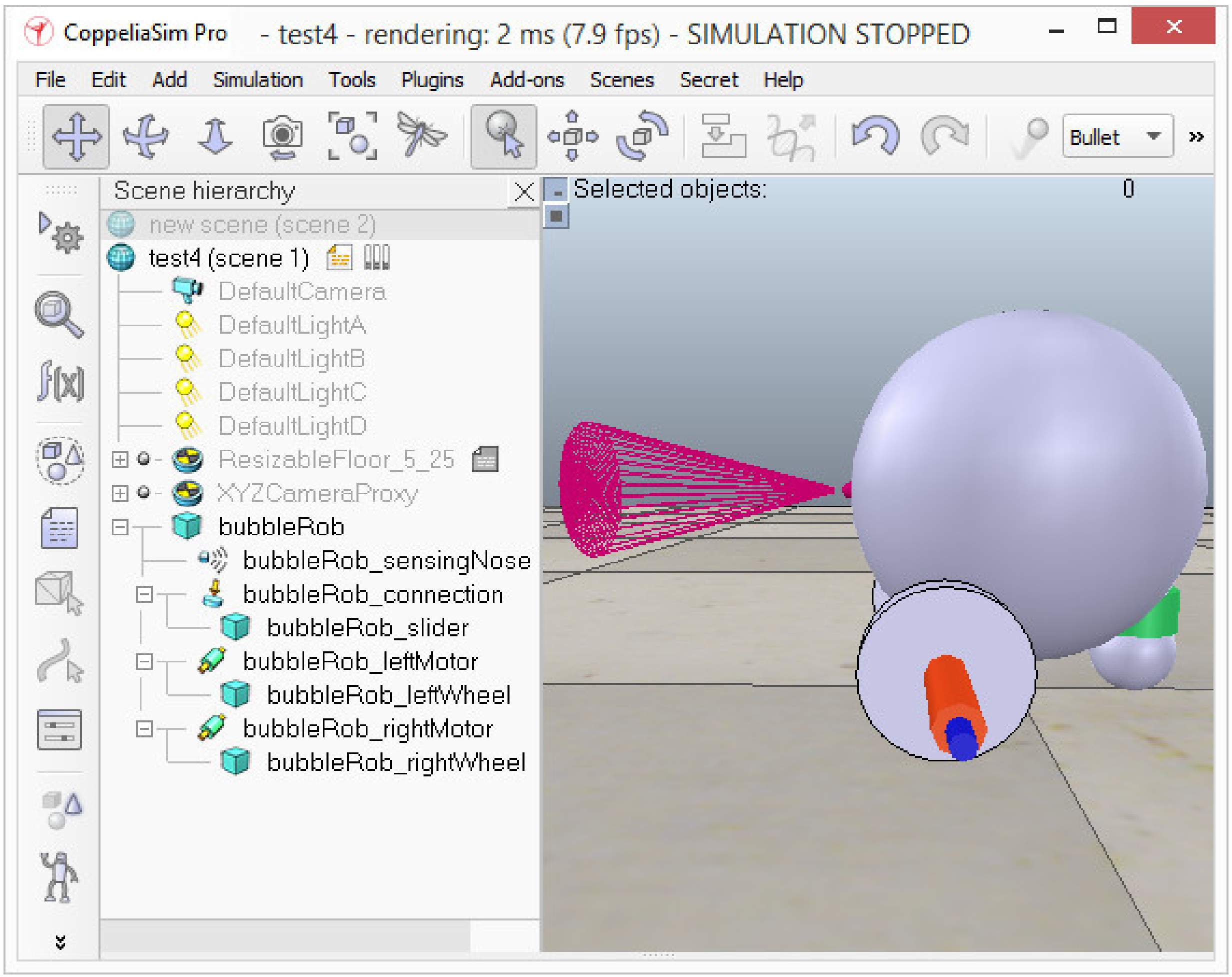
motor, and check item **Lock motor when target velocity is zero**. We now repeat the same procedure for the right motor and rename it to *bubbleRob_rightMotor*. Now we attach the left wheel to the left motor, the right wheel to the right motor, then attach the two motors to *bubbleRob*. This is what we have:


CoppeliaSim Pro - test4 - rendering: 2 ms (8.0 fps) - SIMULATION STOPPED
File Edit Add Simulation Tools Plugins Add-ons Scenes Secret Help
Bullet
Scene hierarchy
Selected objects: 0

new scene (scene 2)
test4 (scene 1)
DefaultCamera
DefaultLightA
DefaultLightB
DefaultLightC
DefaultLightD
ResizableFloor_5_25
bubbleRob
bubbleRob_sensingNose
bubbleRob_leftMotor
bubbleRob_leftWheel
bubbleRob_rightMotor
bubbleRob_rightWheel
XYZCameraProxy

[Proximity sensor, motors and wheels]

We run the simulation and notice that the robot is falling backwards. We are still missing a third contact point to the floor. We now add a small slider (or caster). In a new scene we and add a pure primitive sphere with diameter 0.05 and make the sphere Collidable, Measurable, Renderable and Detectable (if not already enabled), then rename it to *bubbleRob_slider*. We set the **Material** to *noFrictionMaterial* in the shape dynamics properties. To rigidly link the slider with the rest of the robot, we add a force sensor object with [Menu bar --> Add --> Force sensor]. We rename it to *bubbleRob_connection* and shift it up by 0.05. We attach the slider to the force sensor, then copy both objects, switch back to scene 1 and paste them. We then shift the force sensor by -0.07 along the absolute X-axis, then attach it to the robot body. If we run the simulation now, we can notice that the slider is slightly moving in relation to the robot body: this is because both objects (i.e. *bubbleRob_slider* and *bubbleRob*) are colliding with each other. To avoid strange effects during dynamics simulation, we have to inform CoppeliaSim that both objects do not mutually collide, and we do this in following way: in the shape dynamics properties, for *bubbleRob_slider* we set the **local respondable mask** to 00001111, and for *bubbleRob*, we set the **local respondable mask** to 11110000. If we run the simulation again, we can notice that both objects do not interfere anymore. This is what we now have:



[Proximity sensor, motors, wheels and slider]

We run the simulation again and notice that *BubbleRob* slightly moves, even with locked motor. We also try to run the simulation with different physics engines: the result will be different. Stability of dynamic simulations is tightly linked to masses and inertias of the involved non-static shapes. For an explanation of this effect, make sure to carefully read this and that sections. We now try to correct for that undesired effect. We select the two wheels and the slider, and in the shape dynamics dialog we click three times **M=M*2 (for selection)**. The effect is that all selected shapes will have their masses multiplied by 8. We do the same with the inertias of the 3 selected shapes, then run the simulation again: stability has improved. In the joint dynamics dialog, we set the **Target velocity** to 50 for both motors. We run the simulation: *BubbleRob* now moves forward and eventually falls off the floor. We reset the **Target velocity** item to zero for both motors.

The object *bubbleRob* is at the base of all objects that will later form the *BubbleRob* model. We will define the model a little bit later. Next we are going to add a graph object to *BubbleRob* in order to display its clearance distance. We click [Menu bar --

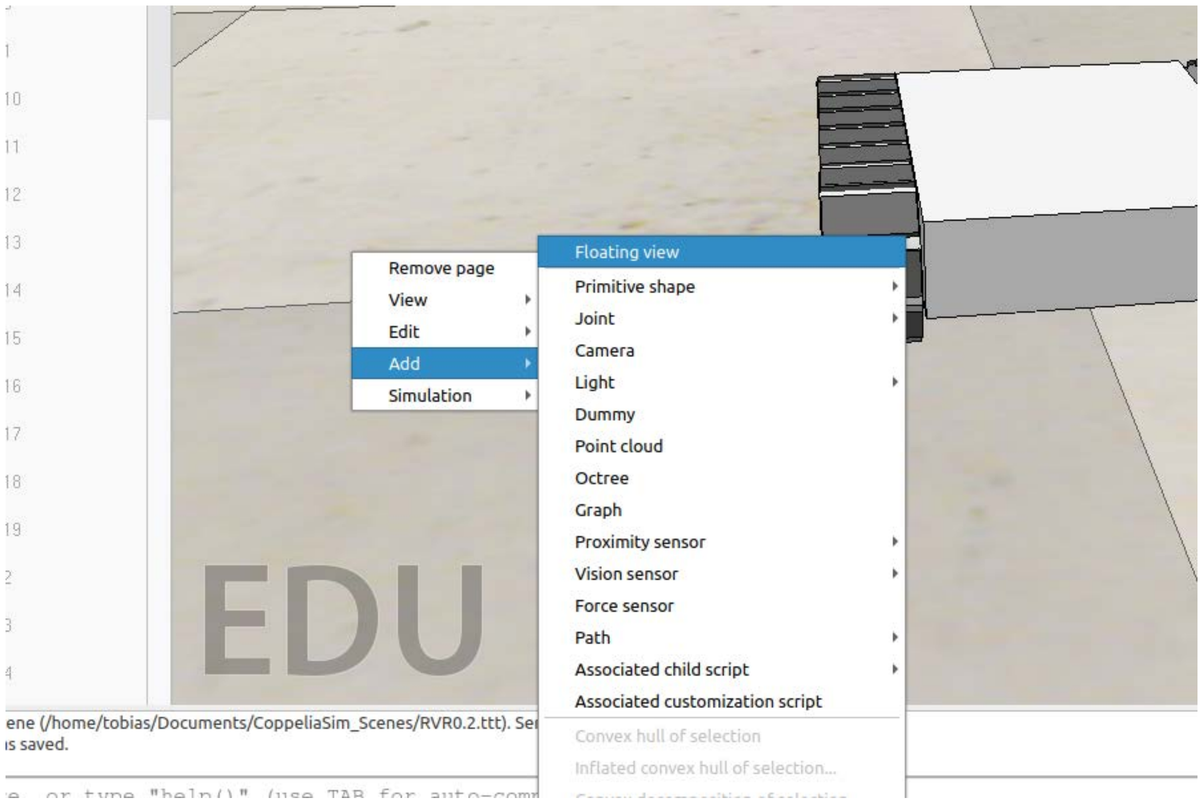
> Add --> Graph] and rename it to *bubbleRob_graph*. We attach the graph to *bubbleRob*, and set the graph's absolute coordinates to (0,0,0.005).

We add a pure primitive cylinder with following dimensions: (0.1, 0.1, 0.2). We want this cylinder to be static (i.e. not influenced by gravity or collisions) but still exerting some collision responses on non-static respondable shapes. For this, we disable **Body is dynamic** in the shape dynamics properties. We also want our cylinder to be Collidable, Measurable, Renderable and Detectable. We do this in the object common properties. Now, while the cylinder is still selected, we click the object translation toolbar button:

Now we can drag any point in the scene: the cylinder will follow the movement while always being constrained to keep the same Z-coordinate. We copy and paste the cylinder a few times, and move them to positions around *BubbleRob* (it is most convenient to perform that while looking at the scene from the top). During object shifting, holding down the shift key allows to perform smaller shift steps. Holding down the ctrl key allows to move in an orthogonal direction to the *regular* direction(s). When done, select the camera pan toolbar button again:

We set a **target velocity** of 50 for the left motor and run the simulation. Without the the LUA script that we will add in the end, the graph view should be still be empty and BubbleRob simply turns to the right and bumps into the cylinders. We stop the simulation and reset the target velocity to zero.

Next we will add a vision sensor, at the same position and orientation as *BubbleRob's* proximity sensor. We open the model hierarchy again, then click [Menu bar --> Add --> Vision sensor --> Perspective type], then attach the vision sensor to the proximity sensor, and set the local position and orientation of the vision sensor to (0,0,0). We also make sure the vision sensor is not not visible, not part of the model bounding box, and that if clicked, the model will be selected instead. In order to customize the vision sensor, we open its properties dialog. We set the **Far clipping plane** item to 1, and the **Resolution x** and **Resolution y** items to 256 and 256. We add a floating view to the scene by right clicking in the scene where the BubbleRob stands [Add --> Floating view], and over the newly added floating view, right-click [Popup menu --> View --> Associate view with selected vision sensor] (we make sure the vision sensor is selected during that process).



ene (/home/tobias/Documents/CoppeliaSim_Scenes/RVR0.2.ttt). Se
is saved.

We attach a child script to the vision sensor by clicking [Menu bar --> Add --> Associated child script --> Non threaded]. We double-click the icon that appeared next to the vision sensor in the scene hierarchy: this opens the child script that we just added. We copy and paste following code into the script editor, then close it:

```
function sysCall_vision(inData)
    simVision.sensorImgToWorkImg(inData.handle) -- copy the vision sensor image to the work image
    simVision.edgeDetectionOnWorkImg(inData.handle,0.2) -- perform edge detection on the work image
    simVision.workImgToSensorImg(inData.handle) -- copy the work image to the vision sensor image buffer
end

function sysCall_init()
end
```

To be able to see the vision sensor's image, we start the simulation, then stop it again.

We now need to finish **BubbleRob** as a model definition. We select the model base (i.e. object *bubbleRob*) then check items **Object is model base** and **Object/model can transfer or accept DNA** in the object common properties: there is now a stippled bounding box that encompasses all objects in the model hierarchy. We select the two joints, the proximity sensor and the graph, then enable item **Ignored by model bounding box** and click **Apply to selection**, in the same dialog: the model bounding box now ignores the two joints and the proximity sensor. Still in the same dialog, we disable **camera visibility layer** 2, and enable **camera visibility layer** 10 for the two joints and the force sensor: this effectively hides the two joints and the force sensor, since layers 9-16 are disabled by default. At any time we can modify the visibility layers for the whole scene. To finish the model definition, we select the vision sensor, the two wheels, the slider, and the graph, then enable item **Select base of model instead**: if we now try to select an object in our model in the scene, the whole model will be selected instead, which is a convenient way to handle and manipulate the whole model as a single object. Additionally, this protects the model against inadvertant modification. Individual objects in the model can still be selected in the scene by click-selecting them with control-shift, or normally selecting them in the scene hierarchy. We finally collapse the model tree in the scene hierarchy.

The last thing that we need for our scene is a small child script that will control *BubbleRob's* behavior. We select *bubbleRob* and click [Menu bar --> Add --> Associated child script --> Non threaded]. We double-click the script icon that appeared next to *bubbleRob's* name in the scene hierarchy and copy and paste following code into the script editor, then close it:

```
function speedChange_callback(ui,id,newVal)
   speed=minMaxSpeed[1]+(minMaxSpeed[2]-minMaxSpeed[1])*newVal/100
end

function sysCall_init()
   -- This is executed exactly once, the first time this script is executed
   bubbleRobBase=sim.getObjectAssociatedWithScript(sim.handle_self) -- this
is bubbleRob's handle
   leftMotor=sim.getObjectHandle("bubbleRob_leftMotor") -- Handle of the left
motor
   rightMotor=sim.getObjectHandle("bubbleRob_rightMotor") -- Handle of the
right motor
   noseSensor=sim.getObjectHandle("bubbleRob_sensingNose") -- Handle of
the proximity sensor
   minMaxSpeed={50*math.pi/180,300*math.pi/180} -- Min and max speeds for
each motor
   backUntilTime=-1 -- Tells whether bubbleRob is in forward or backward
mode
   robotCollection=sim.createCollection(0)
   sim.addItemToCollection(robotCollection,sim.handle_tree,bubbleRobBase,0)
   distanceSegment=sim.addDrawingObject(sim.drawing_lines,4,0,-1,1,{0,1,0})

robotTrace=sim.addDrawingObject(sim.drawing_linestrip+sim.drawing_cyclic,
2,0,-1,200,{1,1,0},nil,nil,{1,1,0})
   graph=sim.getObjectHandle('bubbleRob_graph')
   distStream=sim.addGraphStream(graph,'bubbleRob clearance','m',0,{1,0,0})
   -- Create the custom UI:
      xml = '<ui title="'..sim.getObjectName(bubbleRobBase)..' speed"
closeable="false" resizeable="false" activate="false">'..[[
        <hslider minimum="0" maximum="100"
onchange="speedChange_callback" id="1"/>
        <label text="" style="* {margin-left: 300px;}"/>
        </ui>
        ]]
    ui=simUI.create(xml)
    speed=(minMaxSpeed[1]+minMaxSpeed[2])*0.5
    simUI.setSliderValue(ui,1,100*(speed-minMaxSpeed[1])/(minMaxSpeed[2]-
minMaxSpeed[1]))
end

function sysCall_sensing()
    local result,distData=sim.checkDistance(robotCollection,sim.handle_all)
    if result>0 then
        sim.addDrawingObjectItem(distanceSegment,nil)
        sim.addDrawingObjectItem(distanceSegment,distData)
        sim.setGraphStreamValue(graph,distStream,distData[7])
    end
    local p=sim.getObjectPosition(bubbleRobBase,-1)
    sim.addDrawingObjectItem(robotTrace,p)
end

function sysCall_actuation()
    result=sim.readProximitySensor(noseSensor) -- Read the proximity sensor
    -- If we detected something, we set the backward mode:
    if (result>0) then backUntilTime=sim.getSimulationTime()+4 end

    if (backUntilTime<sim.getSimulationTime()) then
        -- When in forward mode, we simply move forward at the desired speed
        sim.setJointTargetVelocity(leftMotor,speed)
        sim.setJointTargetVelocity(rightMotor,speed)
    else
        -- When in backward mode, we simply backup in a curve at reduced speed
        sim.setJointTargetVelocity(leftMotor,-speed/2)
        sim.setJointTargetVelocity(rightMotor,-speed/8)
    end
end
function sysCall_cleanup()
        simUI.destroy(ui)
end
```

We run the simulation. *BubbleRob* now moves forward while trying to avoid obstacles (in a very basic fashion). While the simulation is still running, change *BubbleRob's* velocity, and copy/paste it a few times. Also try to scale a few of them while the simulation is still running. Be aware that the minimum distance calculation functionality might be heavily slowing down the simulation, depending on the environment.

Part 2 – Remote API

In the next part we will learn how to control the BubbleRob in Coppeliasim with an external Python script over the remote API.

First we save our current status from the tutorial under „bubbleRob.ttt“ [Menu bar --> File --> save scene]. Then we create a copy of that file for our next steps under the name „bubbleRob_GUI.ttt“ [Menu bar --> File --> save scene as --> CoppeliaSim scene…]. Now delete every cylinder this scene so BubbleRob has enough space to drive arround. Next open the **child script** of the BubbleRobs body and delte the code.

After that we make sure that the speed of BubbleRobs motors is 0. Double klick the Icon of **bubbleRob_leftMotor**, then open the **dynamic properties dialog** and set the target velocity to 0. Do the same for **bubbleRob_rightMotor**.

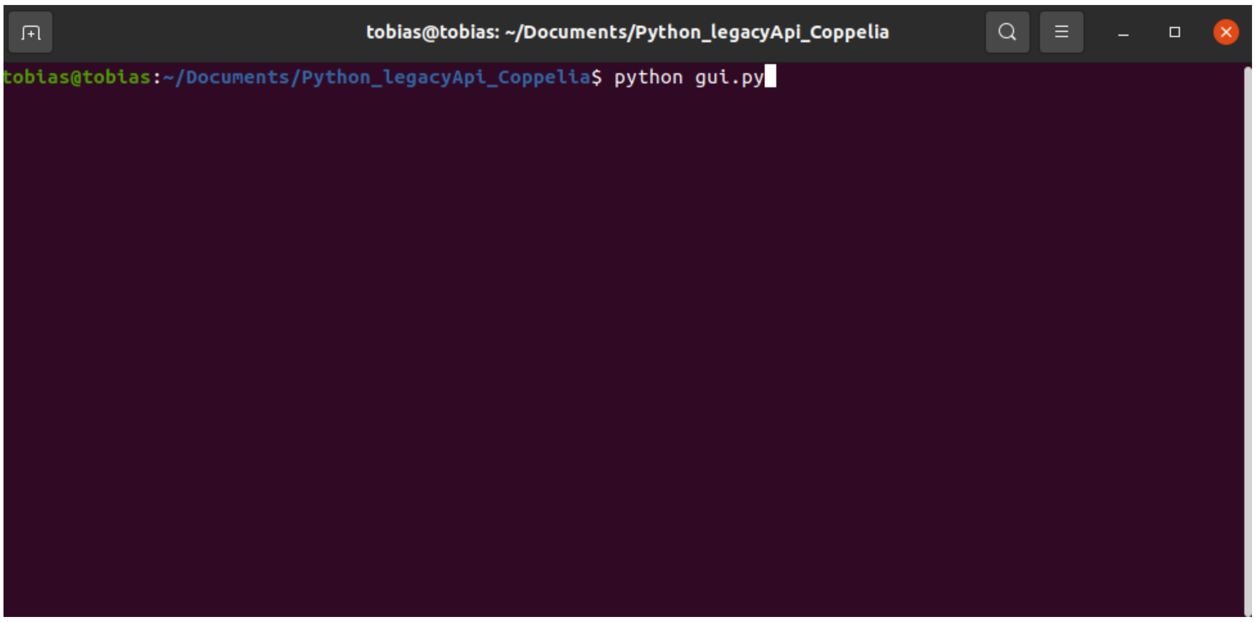
Now our scene is prepared for our external Script. For our GUI we need to install the packet **pyside6** with the python packet manager. Open a terminal [strg+alt+t] and type in : pip install pyside6. Now open a code editor of your choice and paste this code in a new file:

```
#!/usr/bin/env python3

# coding: utf-8

import sys

import os

#this is the module for our GUI

from PySide6.QtWidgets import (QLineEdit, QPushButton, QApplication,

   QVBoxLayout, QDialog, QGridLayout)


try:

   #This module provides the methods to use CoppeliaSim remote API

   import sim

except:

   print ('--------------------------------------------------------------')

   print ('"sim.py" could not be imported. This means very probably that')

   print ('either "sim.py" or the remoteApi library could not be found.')
```

```
    print ('Make sure both are in the same folder as this file,')
    print ('or appropriately adjust the file "sim.py"')
    print ('----------------------------------------------------------')
    print ('')

import time

#This is the class of our GUI. In the main we create an Instance of this class.
class Form(QDialog):

    def __init__(self, clientID, leftMotor, rightMotor, parent=None):

        super(Form, self).__init__(parent)

        # Initialize client, motors and speed
        self.leftMotor = leftMotor
        self.rightMotor = rightMotor
        self.clientID = clientID
        self.speed = 1.0

        # Create button objects
        self.buttonStart = QPushButton("Start")
        self.buttonStop = QPushButton("Stop")
        # Create the layout
        layout = QGridLayout()
        # Order the buttons in the layout first number is the row, second is the column
        layout.addWidget(self.buttonStart,4,1)
        layout.addWidget(self.buttonStop,5,1)
        # Set dialog layout
        self.setLayout(layout)

        # Add the methods to the buttons that should get executed when you
press on them

        self.buttonStart.clicked.connect(self.startSim)

        self.buttonStop.clicked.connect(self.stopSim)


    #This method starts the simulation

    def startSim(self):

        status_code_start = sim.simxStartSimulation(self.clientID,
sim.simx_opmode_oneshot)

        print("Simulation started")

    #Stop Simulation

    def stopSim(self):

        #Stop the Simulation

        sim.simxStopSimulation(self.clientID, sim.simx_opmode_oneshot_wait)

        status_code_left = sim.simxSetJointTargetVelocity(self.clientID,
self.leftMotor, 0.0, sim.simx_opmode_blocking)

        status_code_right = sim.simxSetJointTargetVelocity(self.clientID,
self.rightMotor, 0.0, sim.simx_opmode_blocking)

        print("Simulation stopped")


if __name__ == '__main__':


    # just in case, close all opened connections

    sim.simxFinish(-1)

    # Connect to CoppeliaSim and gives back an ClientID, if it was not
successful your ClientID is -1

    clientID=sim.simxStart('127.0.0.1',19997,True,True,5000,5)


    if clientID!=-1:

        #Getting Handles of the two Motors
        return_code_leftMotor,leftMotor = sim.simxGetObjectHandle(clientID,'bubbleRob_leftMotor',sim.simx_opmode_blocking)

        return_code_rightMotor,rightMotor = sim.simxGetObjectHandle(clientID,'bubbleRob_rightMotor',sim.simx_opmode_blocking)

        # Create the Qt Application

        app = QApplication(sys.argv)

        # Create form

        form = Form(clientID, leftMotor, rightMotor)

        #Show Form

        form.show()

        # Run the main Qt loop

        app.exec_()

        #Stop the Simulation

        sim.simxStopSimulation(clientID, sim.simx_opmode_oneshot_wait)

        print("Simulation stopped")

        # Now close the connection to CoppeliaSim:

        sim.simxFinish(clientID)

    else:

        print("Error: couldn't connect to the remote API server")
```

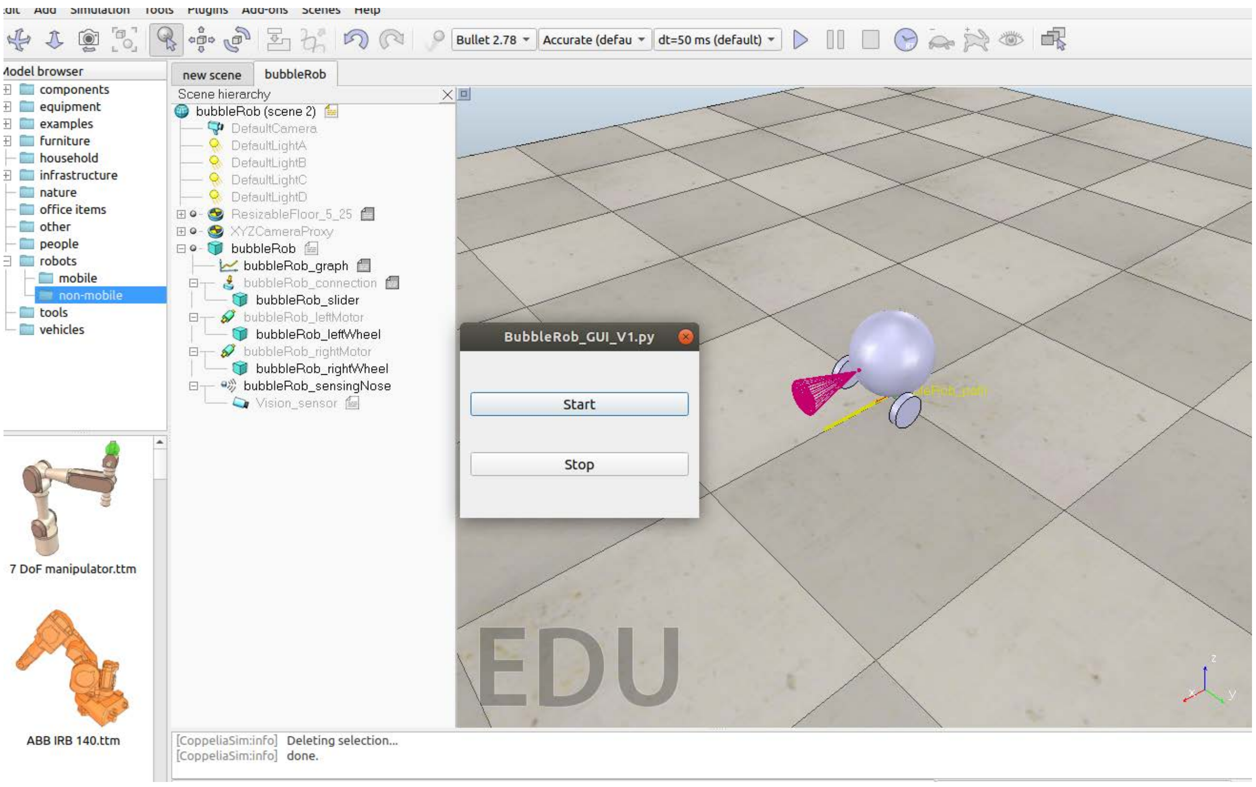
Save that file under „gui.py". Create a folder, name it „coppeliasim_remote_api" and copy your gui.py script in it. Now go to the folder where Coppeliasim is located (should be **~/Documents/CoppeliaSim_Edu_V4_1_0_Ubuntu18_04/**). Open the folder **programming -> remoteApiBindings -> python -> python** and copy the files **sim.py**, **simConst.py** and copy them into your folder where your gui.py file is located. Then copie the file remoteApi.so from **~/Documents/CoppeliaSim_Edu_V4_1_0_Ubuntu18_04/programming/remoteApiBindings/lib/lib/Ubuntu18_04/** and also copy it to your folder.

After that open a terminal in the direction you saved that file and while CoppeliaSim is still open with the bubbleRob scene, execute the script with: python gui.py.



```
tobias@tobias:~/Documents/Python_legacyApi_Coppelia$ python gui.py
```

Now you should see this Gui:



```
[CoppeliaSim:info]  Deleting selection...
[CoppeliaSim:info]  done.
```

If you click the start button the simulation should start and run. Since the BubbleRobs motors are at 0 verlocity it just stands still. By clicking the Stop button the simulation stops.

Now we add some more functionality by adding a few buttons:

self.buttonForward = QpushButton("↑")

```
self.buttonBackward = QPushButton("↓")
self.buttonLeft = QPushButton("←")
self.buttonRight = QPushButton("→")
self.buttonSpinL = QPushButton("Spin left")
self.buttonSpinR = QPushButton("Spin right")
```

Then we change the order in the GUI:

```
layout.addWidget(self.buttonForward,0,1)
layout.addWidget(self.buttonBackward,2,1)
layout.addWidget(self.buttonLeft,2,0)
layout.addWidget(self.buttonRight,2,2)
layout.addWidget(self.buttonStart,4,1)
layout.addWidget(self.buttonStop,5,1)
layout.addWidget(self.buttonSpinL,0,0)
layout.addWidget(self.buttonSpinR,0,2)
```

Then we give the Buttons some more functionality:

```
self.buttonForward.clicked.connect(self.forward)
self.buttonBackward.clicked.connect(self.backward)
self.buttonLeft.clicked.connect(self.left)
self.buttonRight.clicked.connect(self.right)
self.buttonSpinL.clicked.connect(self.spinLeft)
self.buttonSpinR.clicked.connect(self.spinRight)
```

And then we add the methods for the functionalities:

```
# Sets BubbleRob motors speed to drive forward
    def forward(self):
        status_code_left = sim.simxSetJointTargetVelocity(self.clientID,
self.leftMotor, 2.0, sim.simx_opmode_blocking)
        status_code_right = sim.simxSetJointTargetVelocity(self.clientID,
self.rightMotor, 2.0, sim.simx_opmode_blocking)
        self.speed = 1.0
    # Sets BubbleRob motors speed to drive backward
    def backward(self):
        status_code_left = sim.simxSetJointTargetVelocity(self.clientID,
self.leftMotor, -2.0, sim.simx_opmode_blocking)
        status_code_right = sim.simxSetJointTargetVelocity(self.clientID,
self.rightMotor, -2.0, sim.simx_opmode_blocking)
        self.speed = -1.0
    # Sets BubbleRob motors speed to drive left
    def left(self):
        status_code_left = sim.simxSetJointTargetVelocity(self.clientID,
self.leftMotor, 1.0*self.speed, sim.simx_opmode_blocking)
        status_code_right = sim.simxSetJointTargetVelocity(self.clientID,
self.rightMotor, 2.0*self.speed, sim.simx_opmode_blocking)
```

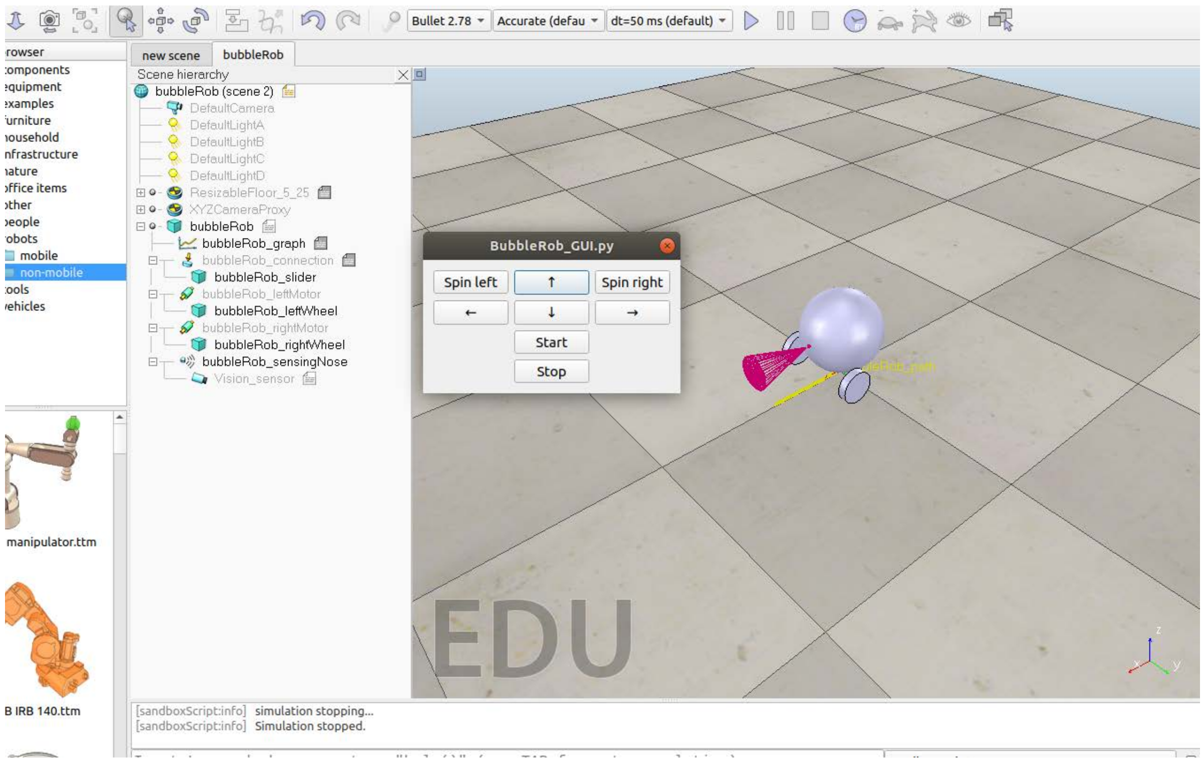
```
   # Sets BubbleRob motors speed to drive right
   def right(self):
      status_code_left = sim.simxSetJointTargetVelocity(self.clientID,
self.leftMotor, 2.0*self.speed, sim.simx_opmode_blocking)
      status_code_right = sim.simxSetJointTargetVelocity(self.clientID,
self.rightMotor, 1.0*self.speed, sim.simx_opmode_blocking)
   # Sets BubbleRob motors speed to spin to the left
   def spinLeft(self):
      status_code_left = sim.simxSetJointTargetVelocity(self.clientID,
self.leftMotor, -0.8, sim.simx_opmode_blocking)
      status_code_right = sim.simxSetJointTargetVelocity(self.clientID,
self.rightMotor, 0.8, sim.simx_opmode_blocking)
   # Sets BubbleRob motors speed to spin to the right
   def spinRight(self):
      status_code_left = sim.simxSetJointTargetVelocity(self.clientID,
self.leftMotor, 0.8, sim.simx_opmode_blocking)
      status_code_right = sim.simxSetJointTargetVelocity(self.clientID,
self.rightMotor, -0.8, sim.simx_opmode_blocking)
```

Your file should now look like this:

```
#!/usr/bin/env python3
# coding: utf-8
import sys
import os
#this is the module for our GUI
from PySide6.QtWidgets import (QLineEdit, QPushButton, QApplication,
   QVBoxLayout, QDialog, QGridLayout)

try:
   #This module provides the methods to use CoppeliaSim remote API
   import sim
except:
   print ('--------------------------------------------------------------')
   print ('"sim.py" could not be imported. This means very probably that')
   print ('either "sim.py" or the remoteApi library could not be found.')
   print ('Make sure both are in the same folder as this file,')
   print ('or appropriately adjust the file "sim.py"')
   print ('--------------------------------------------------------------')
   print ('')

import time

#This is the class of our GUI. In the main we create an Instance of this class.
class Form(QDialog):

   def __init__(self, clientID, leftMotor, rightMotor, parent=None):
        super(Form, self).__init__(parent)

        # Initialize client, motors and speed
        self.leftMotor = leftMotor
        self.rightMotor = rightMotor
        self.clientID = clientID
        self.speed = 1.0

        # Create button objects
        self.buttonForward = QPushButton("↑")
        self.buttonBackward = QPushButton("↓")
        self.buttonLeft = QPushButton("←")
        self.buttonRight = QPushButton("→")
        self.buttonStart = QPushButton("Start")
        self.buttonStop = QPushButton("Stop")
        self.buttonSpinL = QPushButton("Spin left")
        self.buttonSpinR = QPushButton("Spin right")

        # Create the layout
        layout = QGridLayout()
        # Order the buttons in the layout first number is the row, second is the
column
        layout.addWidget(self.buttonForward,0,1)
        layout.addWidget(self.buttonBackward,2,1)
        layout.addWidget(self.buttonLeft,2,0)
        layout.addWidget(self.buttonRight,2,2)
        layout.addWidget(self.buttonStart,4,1)
        layout.addWidget(self.buttonStop,5,1)
        layout.addWidget(self.buttonSpinL,0,0)
        layout.addWidget(self.buttonSpinR,0,2)

        # Set dialog layout
        self.setLayout(layout)
        # Add the methods to the buttons that should get executed when you
press on them
        self.buttonStart.clicked.connect(self.startSim)
        self.buttonStop.clicked.connect(self.stopSim)
        self.buttonForward.clicked.connect(self.forward)
        self.buttonBackward.clicked.connect(self.backward)
        self.buttonLeft.clicked.connect(self.left)
        self.buttonRight.clicked.connect(self.right)
        self.buttonSpinL.clicked.connect(self.spinLeft)
        self.buttonSpinR.clicked.connect(self.spinRight)

    #This method starts the simulation
    def startSim(self):
        status_code_start = sim.simxStartSimulation(self.clientID, 
sim.simx_opmode_oneshot)
        print("Simulation started")
    #Stop Simulation
    def stopSim(self):
        #Stop the Simulation
        sim.simxStopSimulation(self.clientID, sim.simx_opmode_oneshot_wait)
        status_code_left = sim.simxSetJointTargetVelocity(self.clientID, 
self.leftMotor, 0.0, sim.simx_opmode_blocking)
        status_code_right = sim.simxSetJointTargetVelocity(self.clientID, 
self.rightMotor, 0.0, sim.simx_opmode_blocking)
        print("Simulation stopped")
    # Sets BubbleRob motors speed to drive forward
    def forward(self):
        status_code_left = sim.simxSetJointTargetVelocity(self.clientID, 
self.leftMotor, 2.0, sim.simx_opmode_blocking)
        status_code_right = sim.simxSetJointTargetVelocity(self.clientID, 
self.rightMotor, 2.0, sim.simx_opmode_blocking)
        self.speed = 1.0
    # Sets BubbleRob motors speed to drive backward
    def backward(self):
        status_code_left = sim.simxSetJointTargetVelocity(self.clientID, 
self.leftMotor, -2.0, sim.simx_opmode_blocking)
        status_code_right = sim.simxSetJointTargetVelocity(self.clientID, 
self.rightMotor, -2.0, sim.simx_opmode_blocking)
        self.speed = -1.0
    # Sets BubbleRob motors speed to drive left
    def left(self):
        status_code_left = sim.simxSetJointTargetVelocity(self.clientID, 
self.leftMotor, 1.0*self.speed, sim.simx_opmode_blocking)
        status_code_right = sim.simxSetJointTargetVelocity(self.clientID, 
self.rightMotor, 2.0*self.speed, sim.simx_opmode_blocking)
    # Sets BubbleRob motors speed to drive right
    def right(self):
        status_code_left = sim.simxSetJointTargetVelocity(self.clientID, 
self.leftMotor, 2.0*self.speed, sim.simx_opmode_blocking)
        status_code_right = sim.simxSetJointTargetVelocity(self.clientID, 
self.rightMotor, 1.0*self.speed, sim.simx_opmode_blocking)
    # Sets BubbleRob motors speed to spin to the left
    def spinLeft(self):
        status_code_left = sim.simxSetJointTargetVelocity(self.clientID, 
self.leftMotor, -0.8, sim.simx_opmode_blocking)
        status_code_right = sim.simxSetJointTargetVelocity(self.clientID, 
self.rightMotor, 0.8, sim.simx_opmode_blocking)
    # Sets BubbleRob motors speed to spin to the right
    def spinRight(self):
        status_code_left = sim.simxSetJointTargetVelocity(self.clientID, 
self.leftMotor, 0.8, sim.simx_opmode_blocking)
```

```
        status_code_right = sim.simxSetJointTargetVelocity(self.clientID,
self.rightMotor, -0.8, sim.simx_opmode_blocking)

if __name__ == '__main__':

    # just in case, close all opened connections
    sim.simxFinish(-1)
    # Connect to CoppeliaSim and gives back an ClientID, if it was not
successful your ClientID is -1
    clientID=sim.simxStart('127.0.0.1',19997,True,True,5000,5)

    if clientID!=-1:
        #Getting Handles of the two Motors
        return_code_leftMotor,leftMotor =
sim.simxGetObjectHandle(clientID,'bubbleRob_leftMotor',sim.simx_opmode_bl
ocking)
        return_code_rightMotor,rightMotor =
sim.simxGetObjectHandle(clientID,'bubbleRob_rightMotor',sim.simx_opmode_
blocking)
        # Create the Qt Application
        app = QApplication(sys.argv)
        # Create form
        form = Form(clientID, leftMotor, rightMotor)
        #Show Form
        form.show()
        # Run the main Qt loop
        app.exec_()
        #Stop the Simulation
        sim.simxStopSimulation(clientID, sim.simx_opmode_oneshot_wait)
        print("Simulation stopped")
        # Now close the connection to CoppeliaSim:
        sim.simxFinish(clientID)
    else:
        print("Error: couldn't connect to the remote API server")
```

If you run the script you should now have this gui:



```
[sandboxScript:info]  simulation stopping...
[sandboxScript:info]  Simulation stopped.
```

Press the start button, then you can change the direction of the BubbleRob with the arrow buttons. If you press stop the simulation stops.