

Introduction to Robotics and



CoppeliaSim
from the creators of V-REP



Dr. Prashant Upadhyaya

Senior Member-IEEE, Fellow-IETE-Australia, IETE (M)-India

Associate Professor, ECE (AU-1)

Chandigarh University

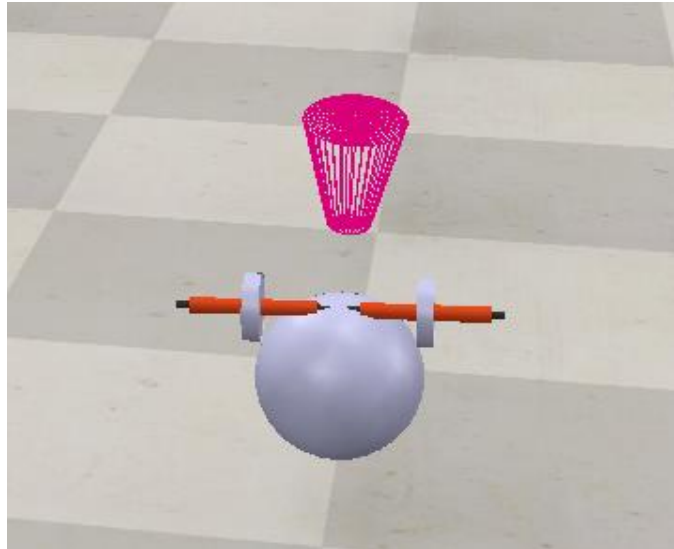
Research Profile - [Dr. Prashant Upadhyaya - Google Scholar](#)

Creating stable: BubbleRob

We **run the simulation** and notice that the **robot is falling backwards.**

We are still missing a third contact point to the floor.

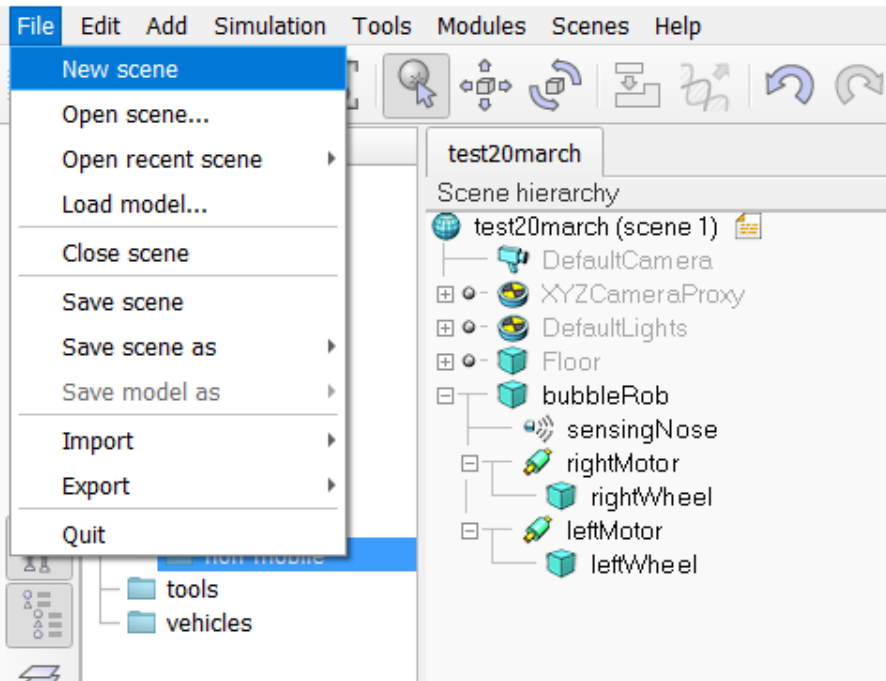
We now add a small slider (or caster).



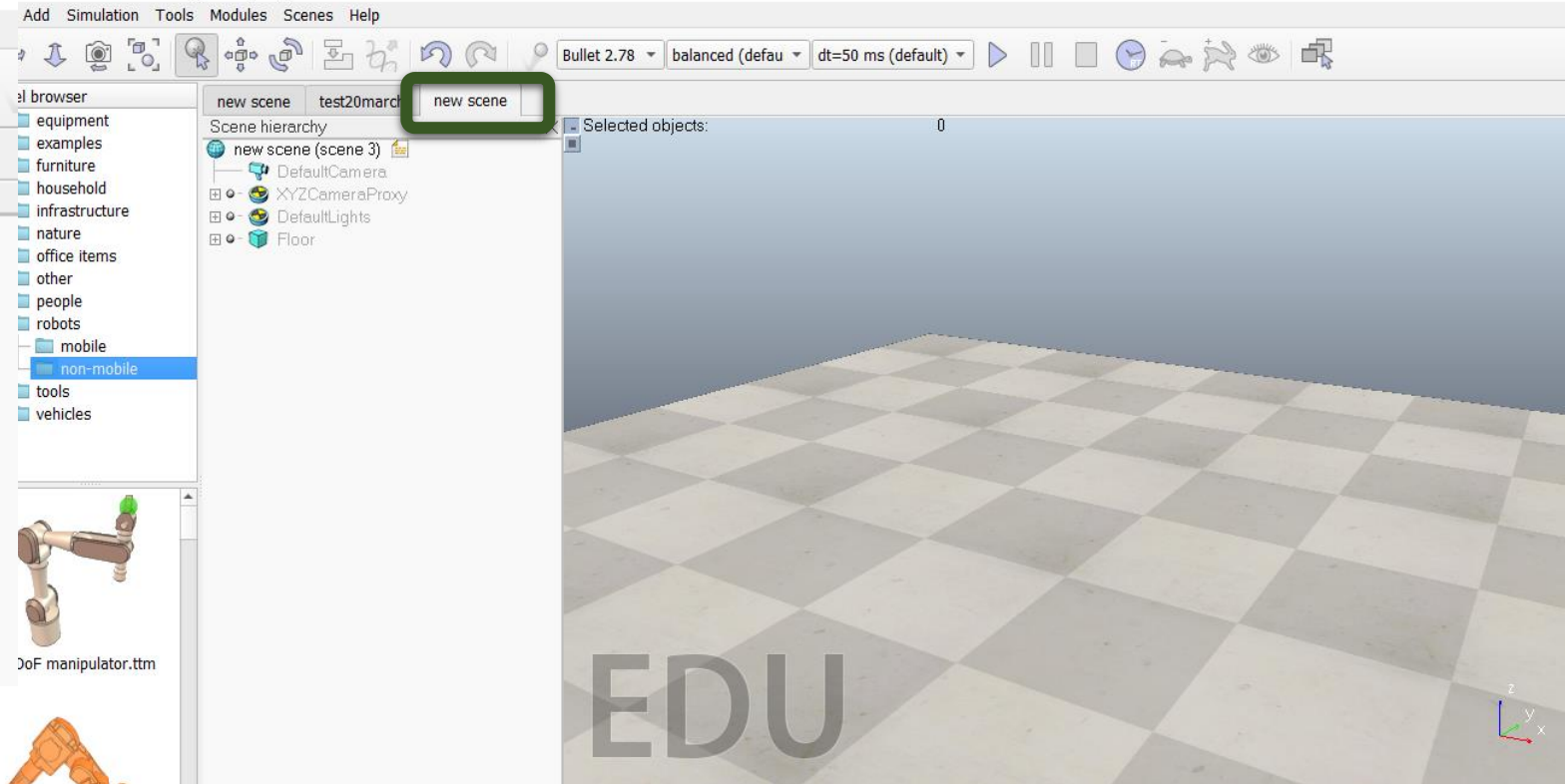
STEP 17

We will design **small slider (or caster)**.
We create a new scene with
[Menu bar --> File --> New scene]

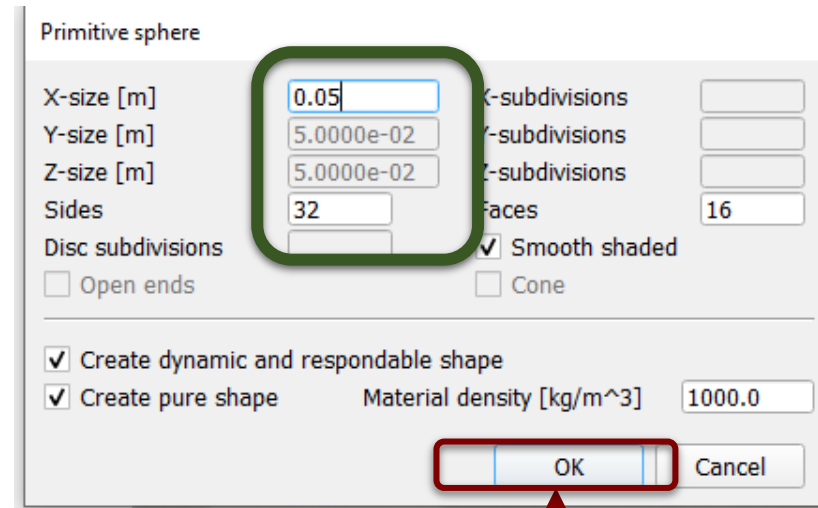
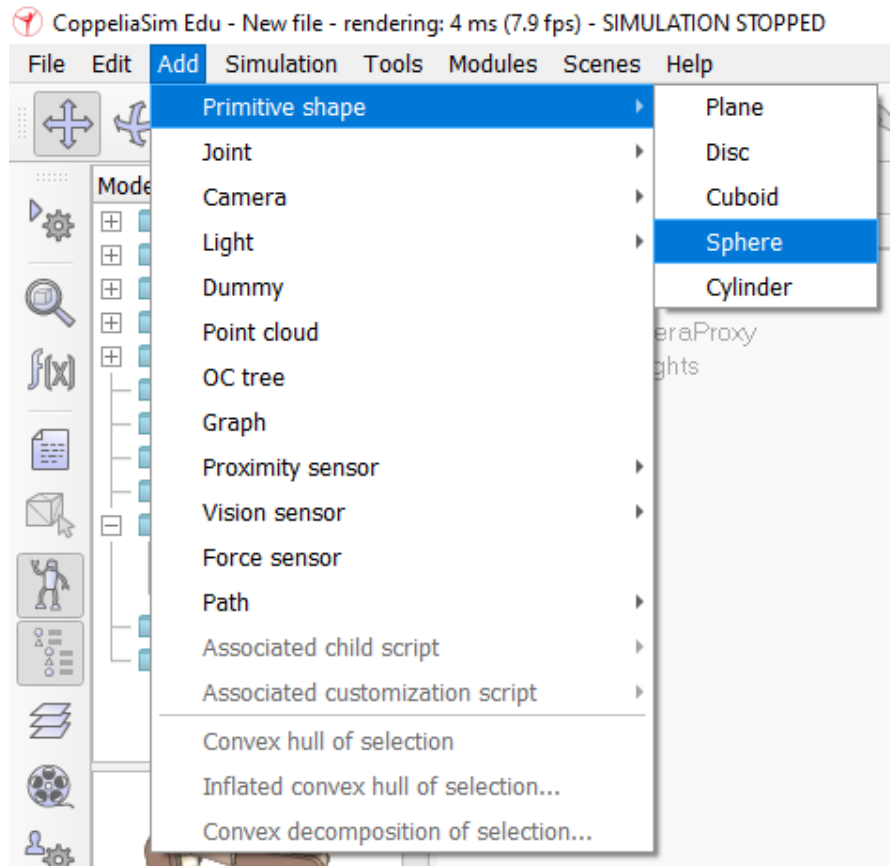
CoppeliaSim Edu - test20march - rendering: 5 ms (8.0 fps) - SIMULATION STOPPED



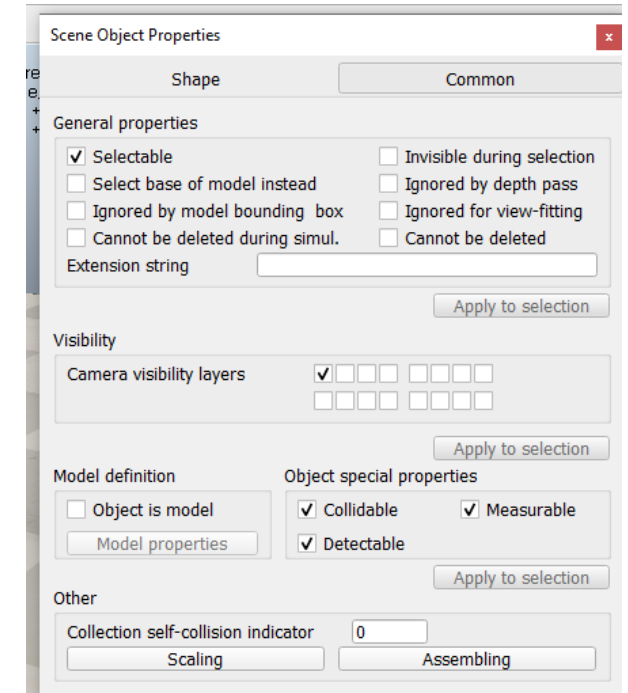
Sim Edu - New file - rendering: 4 ms (7.9 fps) - SIMULATION STOPPED



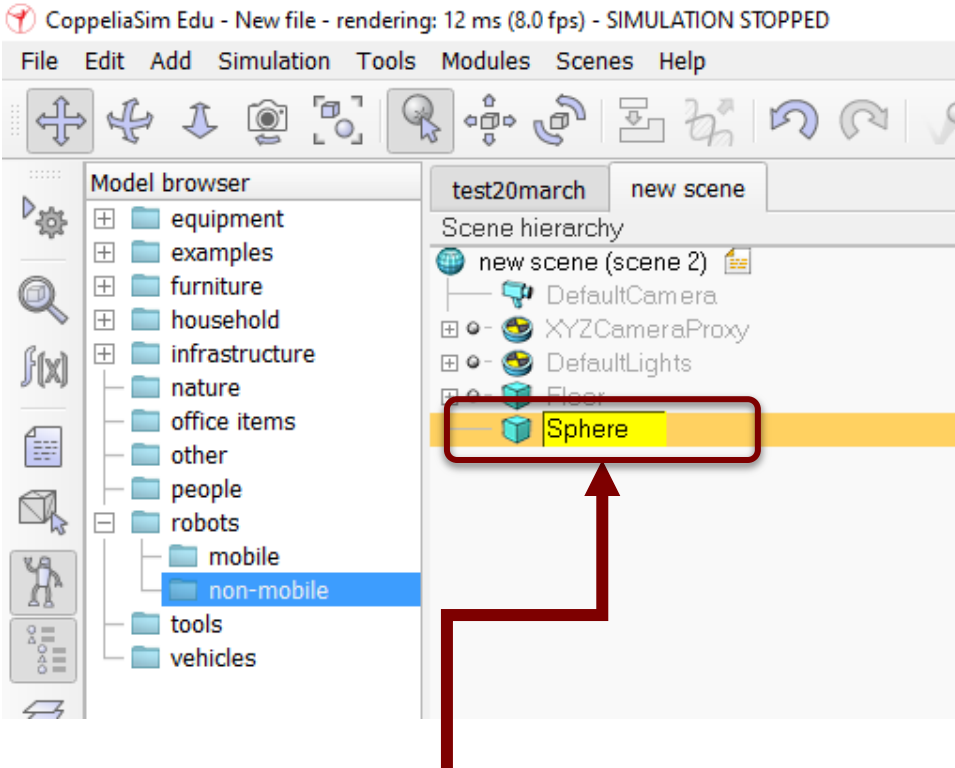
Add a **pure primitive sphere** with **diameter 0.05** and make the sphere **Collidable, Measurable and Detectable** (if not already enabled)



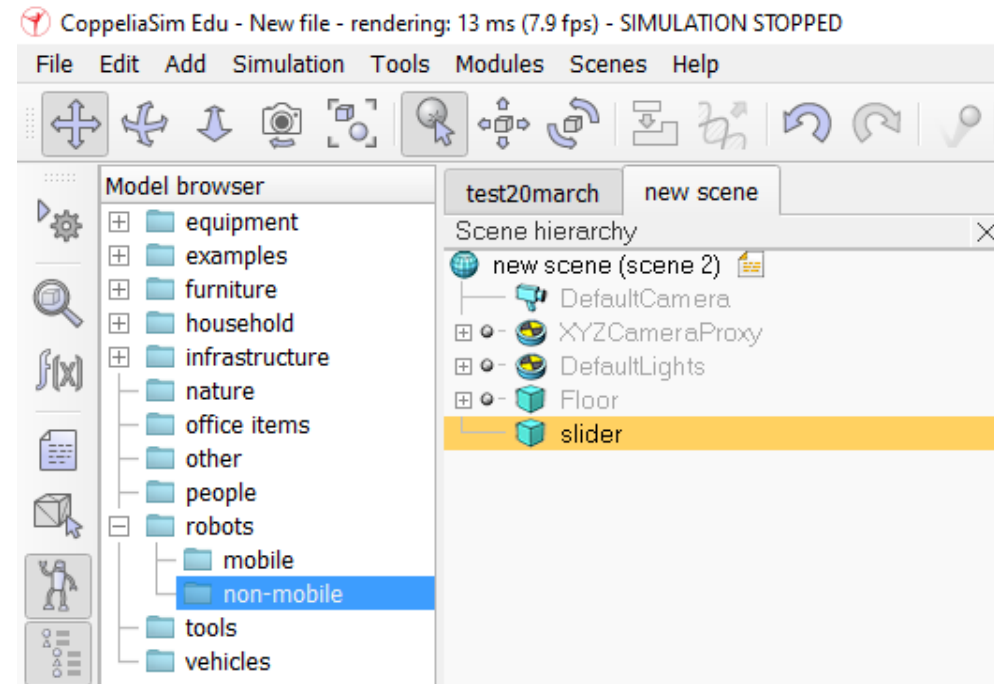
Click **OK**



Rename it to slider

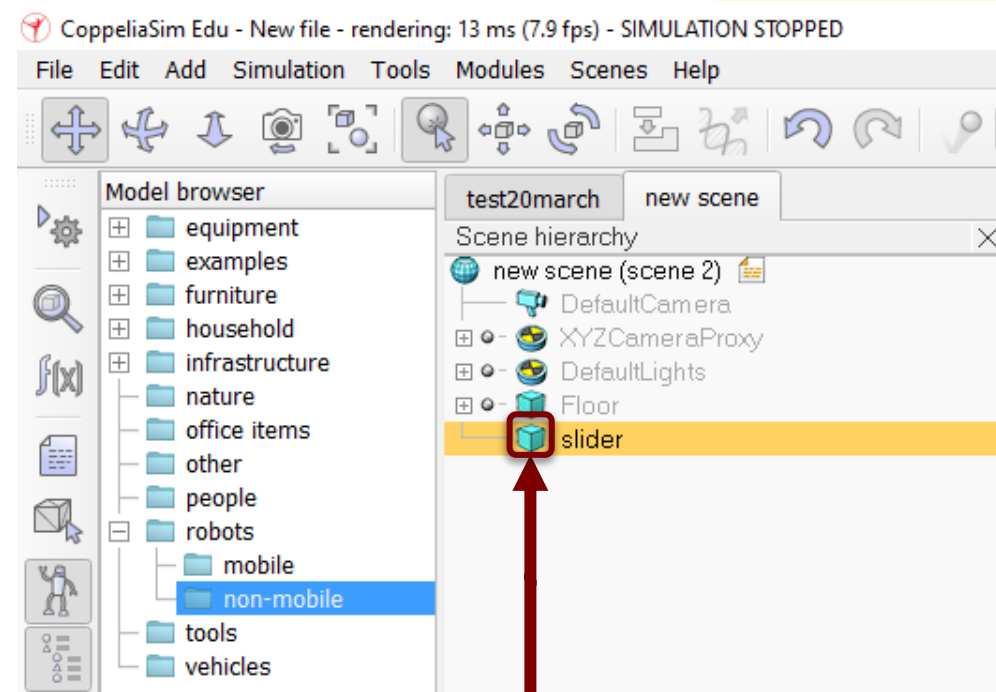


**Double Click on this and
rename it to
slider and Press ENTER**

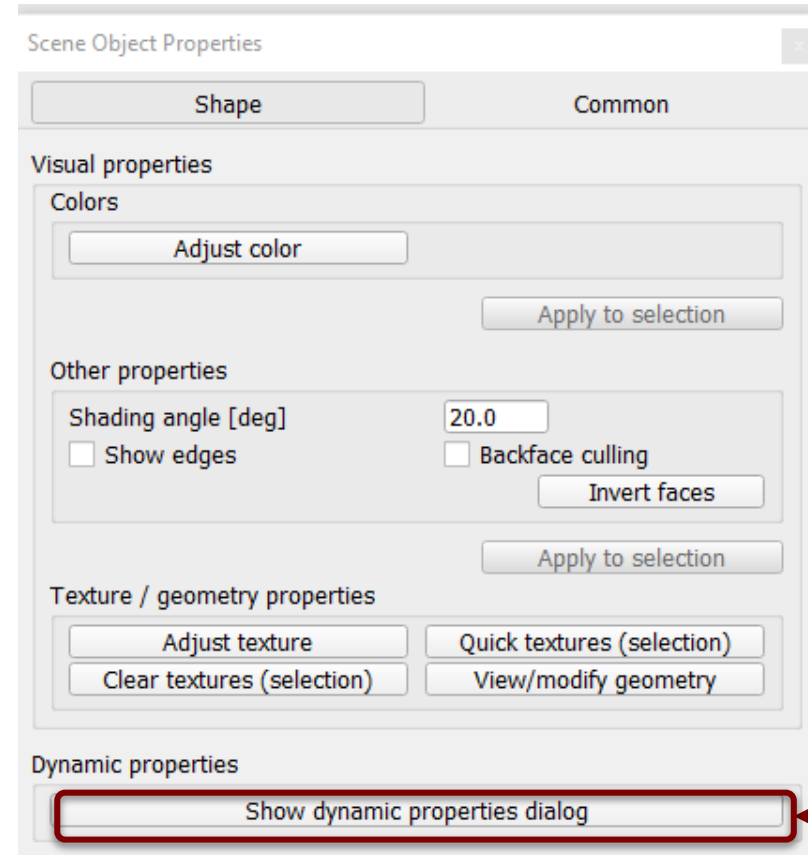


STEP 18

We set the Material to **noFrictionMaterial** in the shape dynamics properties.

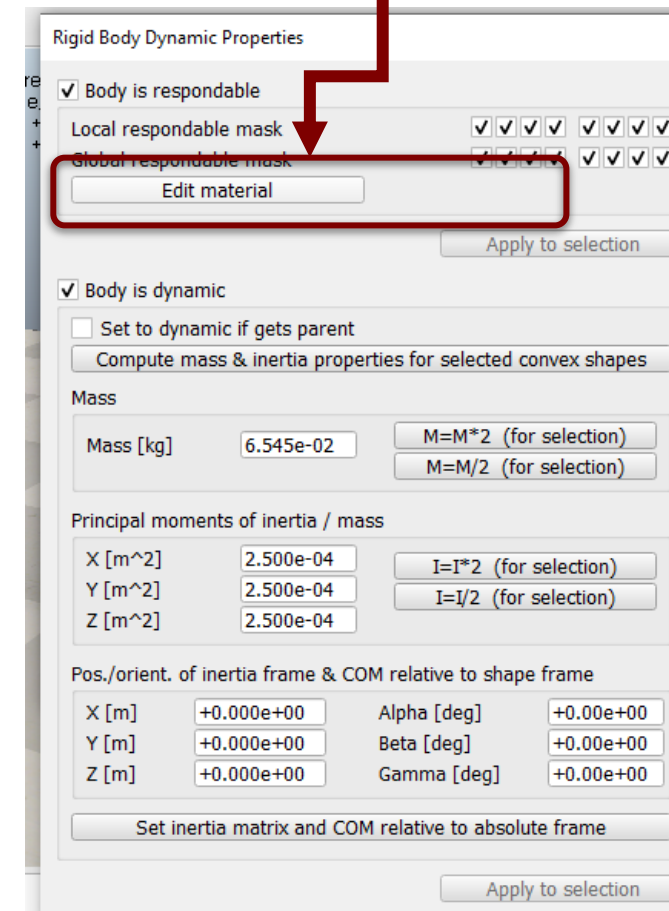


Double Click
on teal
colour shape



Click on this

Click on this



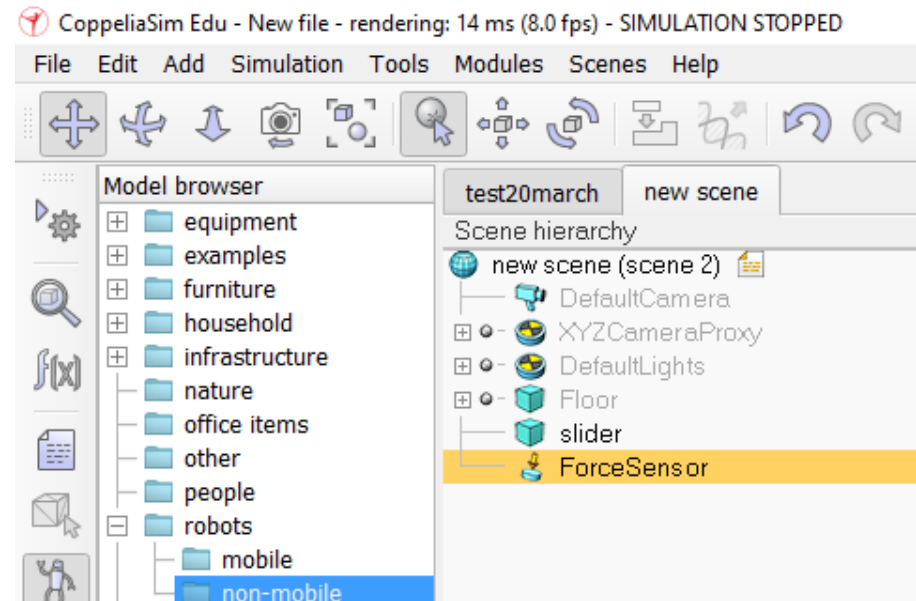
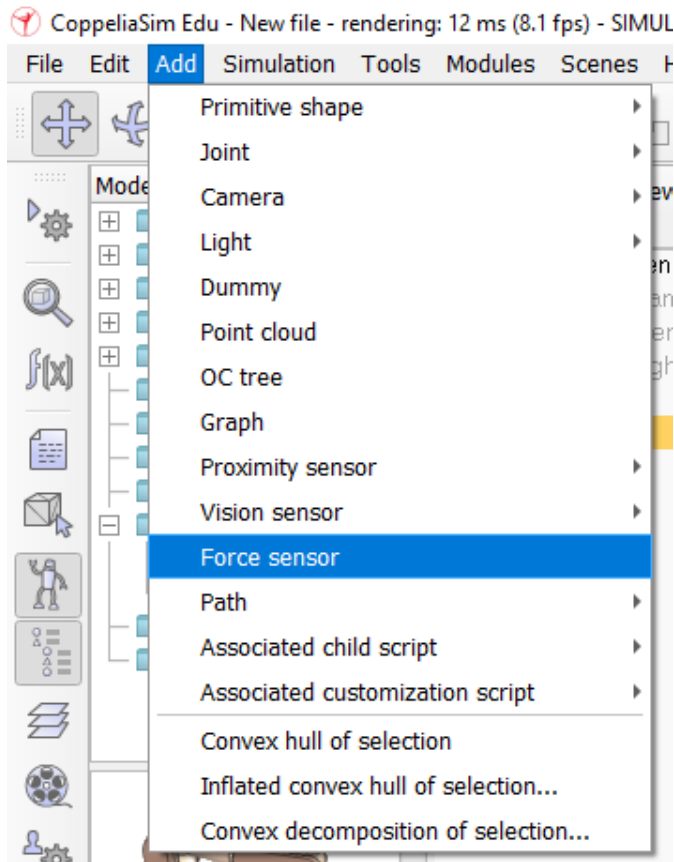
Property	Value
Apply predefined settings:	None
Bullet properties	
Friction (only Bullet V2.78)	1.0000e+00
Friction (after Bullet V2.78)	5.0000e-01
Restitution	0.0000e+00
Linear damping	0.0000e+00
Angular damping	0.0000e+00
Sticky contact (only Bullet V2.78)	<input type="checkbox"/> False
Auto-shrink convex mesh	<input type="checkbox"/> False
Custom collision margin	<input type="checkbox"/> False
Custom collision margin factor	1.0000e-01
Contact properties	
Friction	1.0000e+00
Maximum contacts	64
Soft ERP	2.0000e-01
Soft CFM	0.0000e+00
Linear damping	0.0000e+00
Angular damping	0.0000e+00
Vortex properties	
Restitution	0.0000e+00
Restitution threshold	5.0000e-01
Compliance [s^2/kg]	1.0000e-08
Damping [kg/s]	1.0000e+07
Adhesive force [kg*m/s^2]	0.0000e+00
Linear velocity damping [kg/s]	0.0000e+00
Angular velocity damping [kg*m...	0.0000e+00
Auto angular damping enabled	<input checked="" type="checkbox"/> True
Auto angular damping tension ratio	1.0000e-02
Skin thickness [m]	2.0000e-03
Auto-slip enabled	<input type="checkbox"/> False
Angular normal axis (friction: 0.0000e+00)	
Newton properties	
Static friction	0.0000e+00
Kinetic friction	0.0000e+00
Restitution	0.0000e+00
Linear drag	0.0000e+00
Angular drag	0.0000e+00

Put value zero(0) where ever you find term
Friction in Properties Material

Make it zero

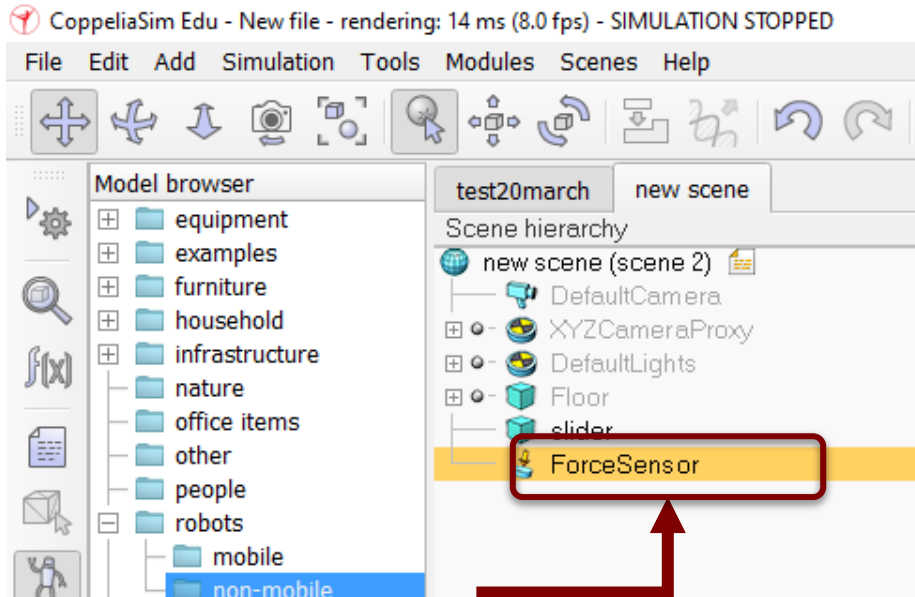
STEP 19

To **rigidly link the slider** with the rest of the robot,
we **add a force sensor** object with
[Menu bar --> Add --> Force sensor]

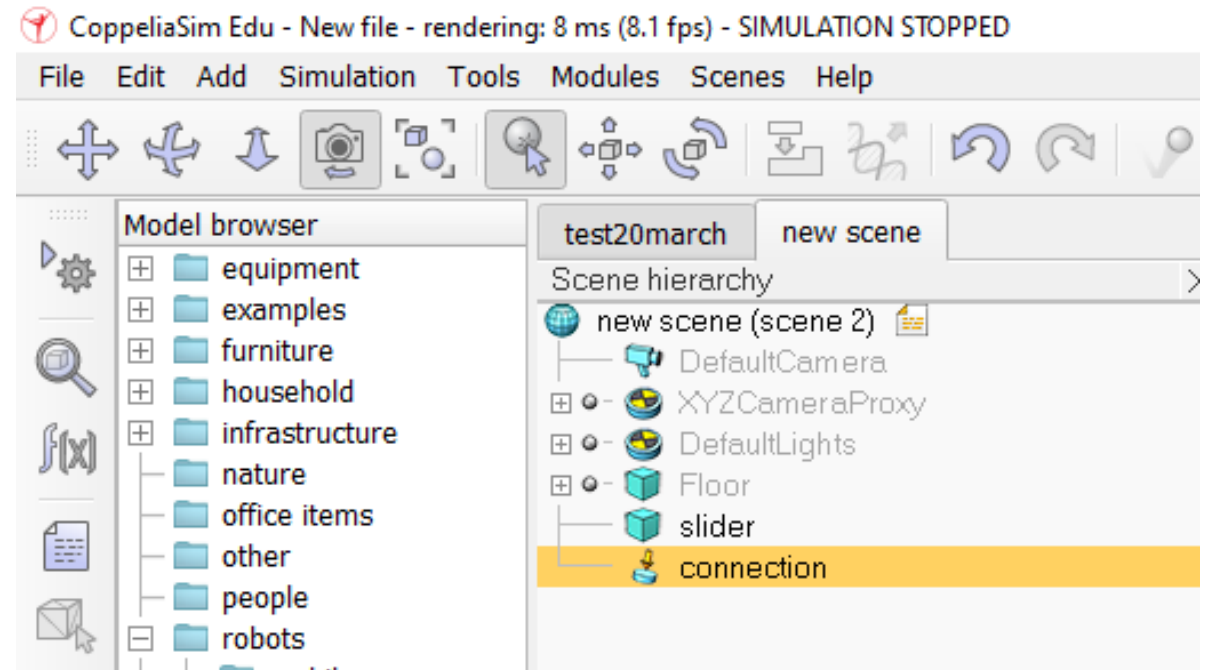


STEP 20

We rename it to **connection** and
shift it up by 0.05

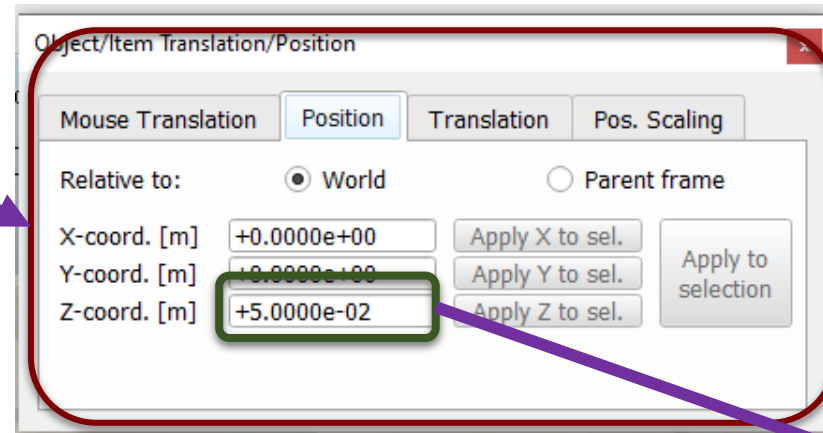
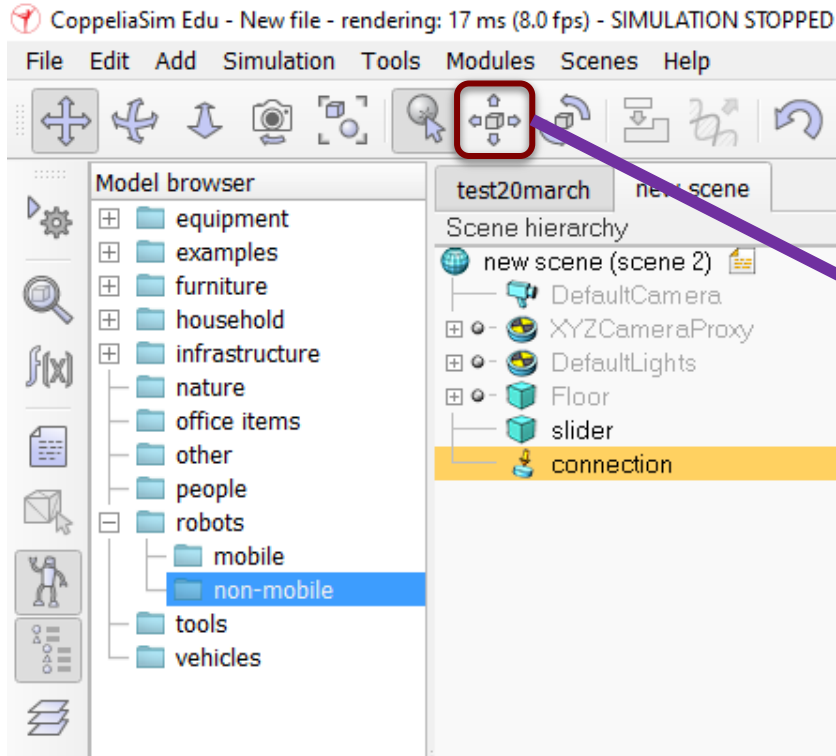


Double Click on this and
rename it to
connection and Press **ENTER**



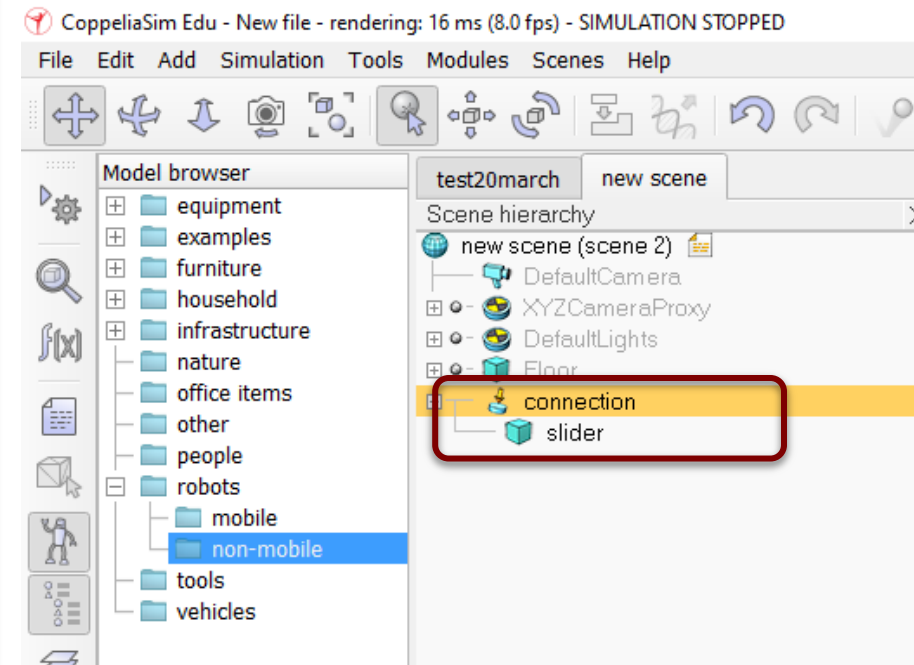
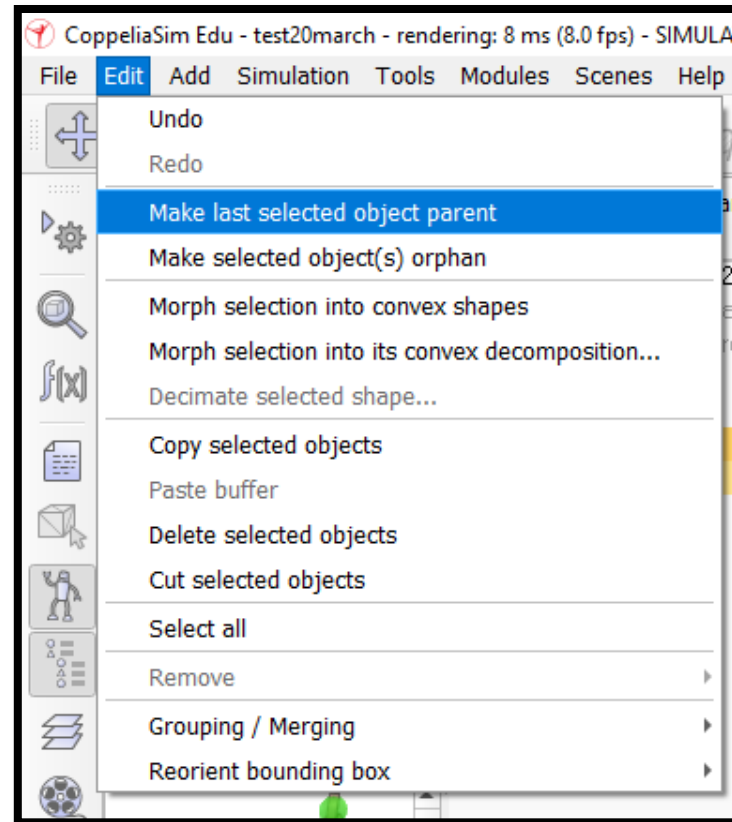
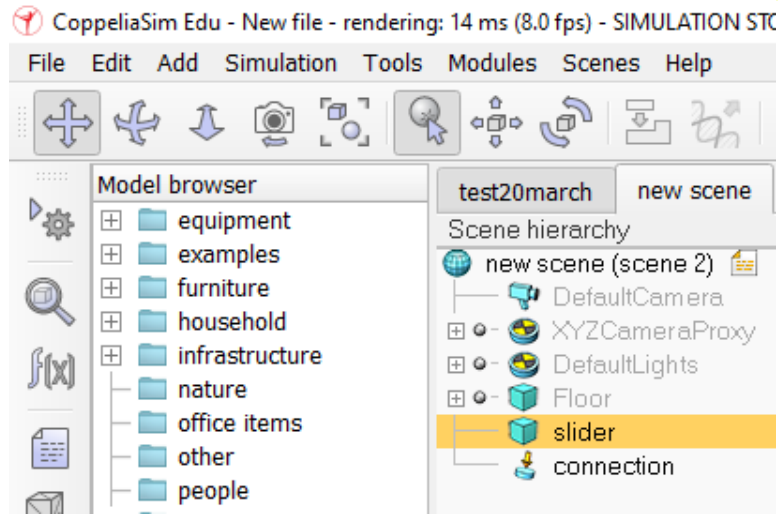
Shift it up by 0.05

(Open position dialogue and put 0.05 in z-axis)

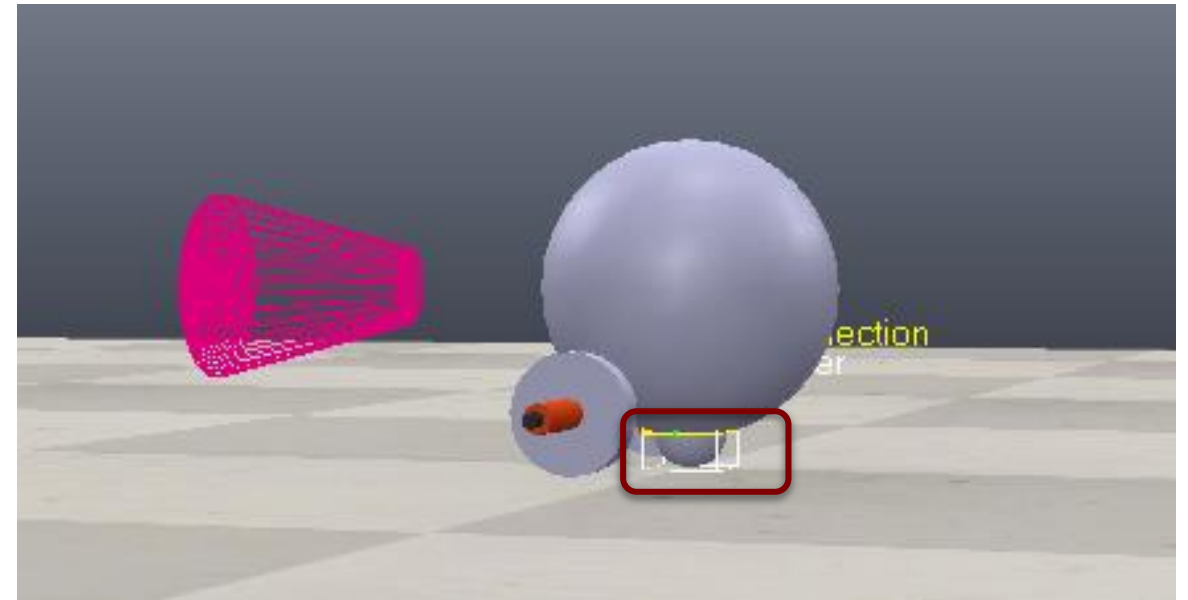
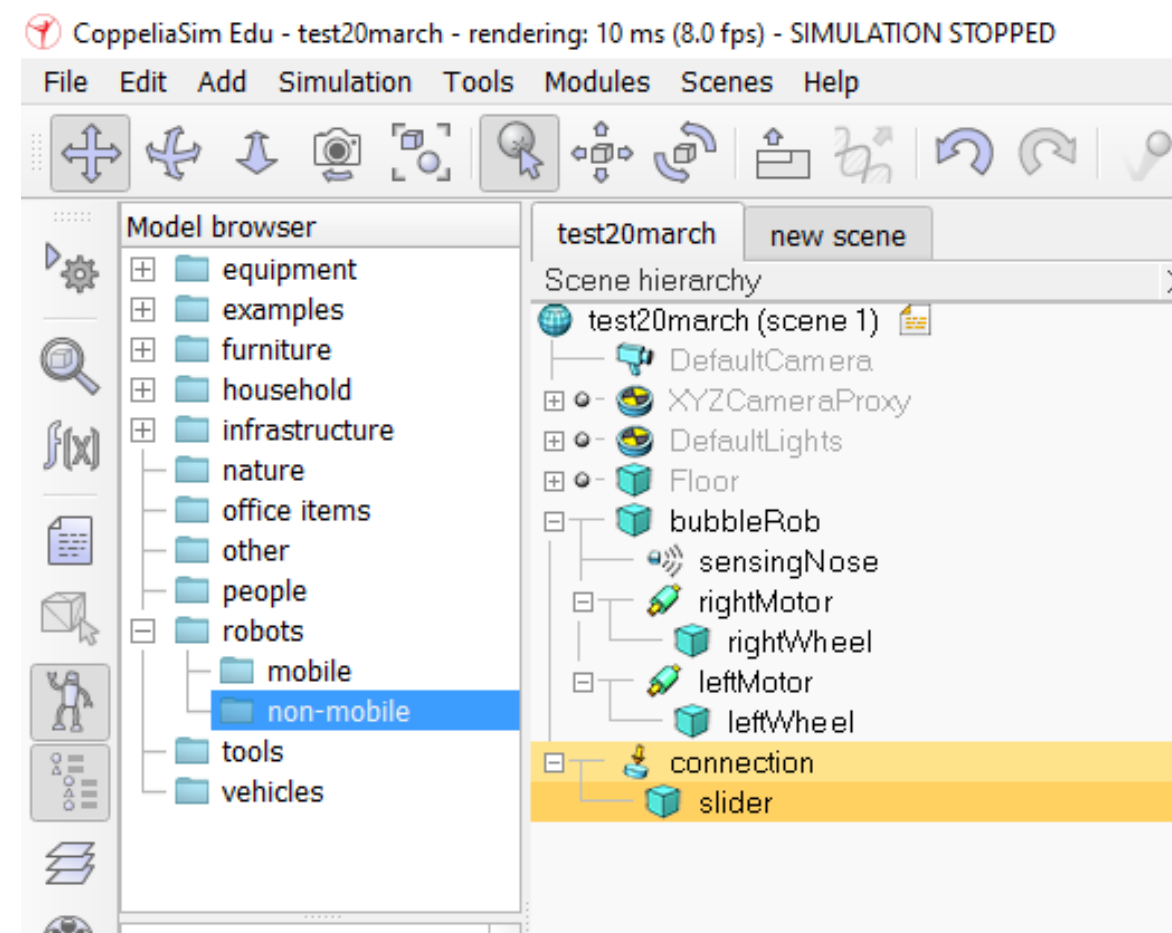


We attach the slider to the force sensor, then copy both objects, switch back to scene 1 and paste them.

We select **slider**, then **control-select connection**, then click
[Menu bar --> Edit --> Make last selected object parent].



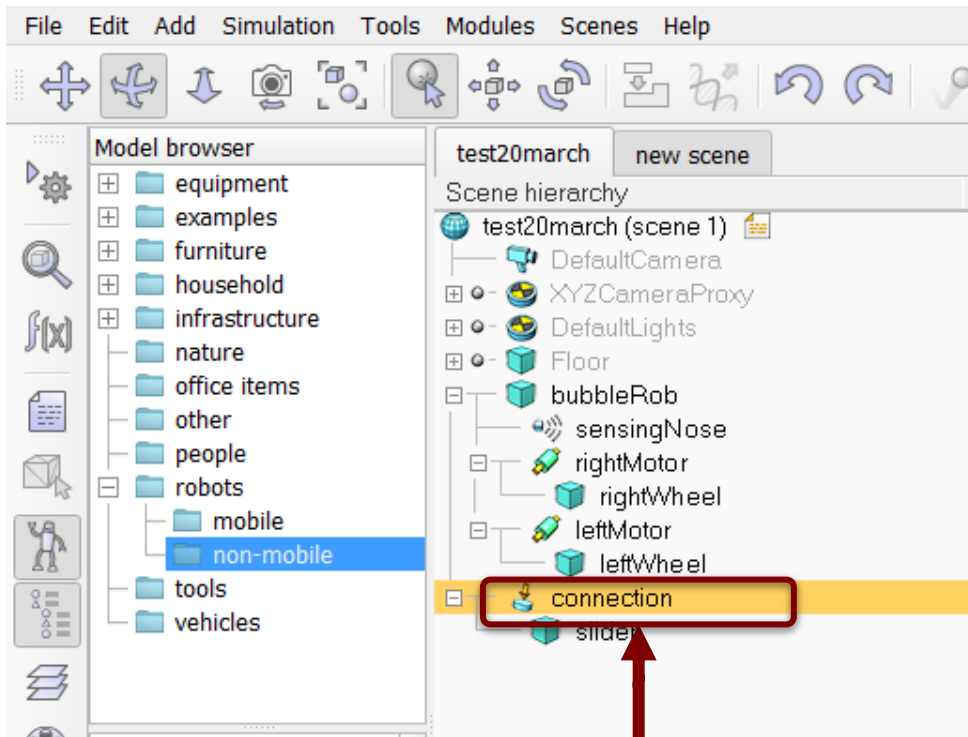
Switch back to **scene 1** and **paste** them



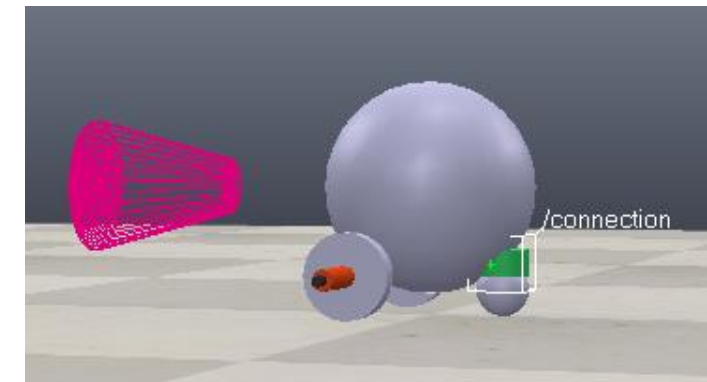
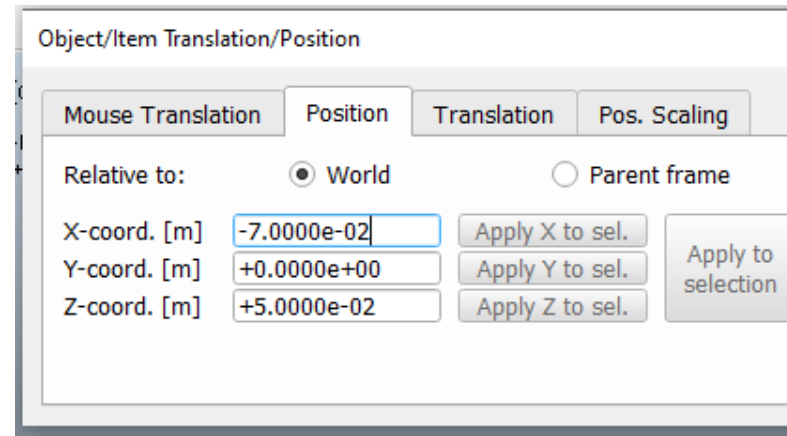
STEP 21

Shift the **force sensor** by **-0.07** along the **absolute X-axis**, then **attach it to the robot body**.

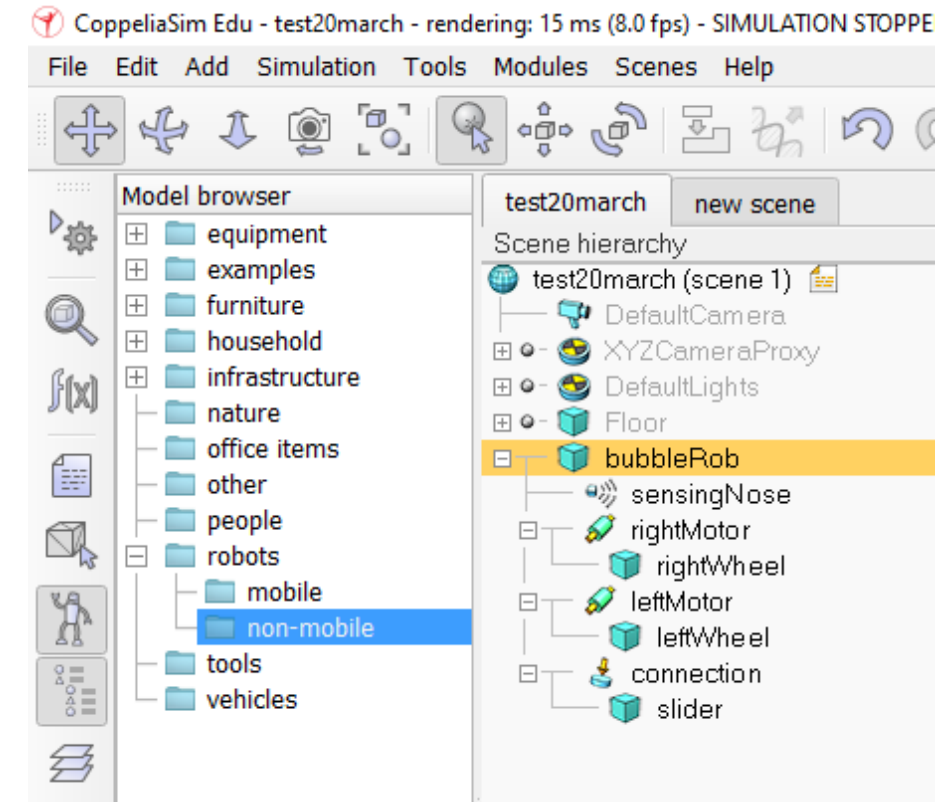
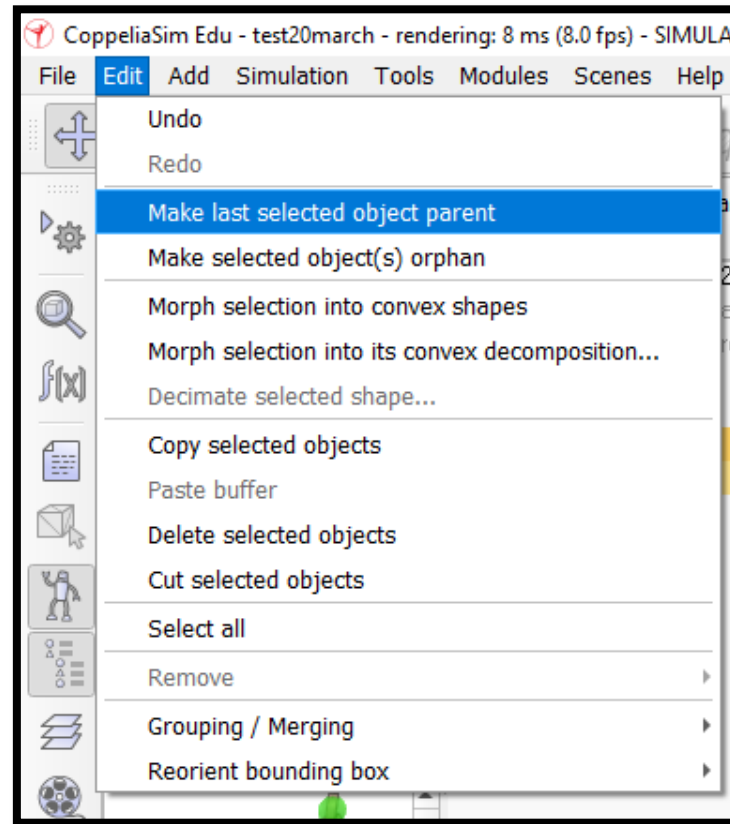
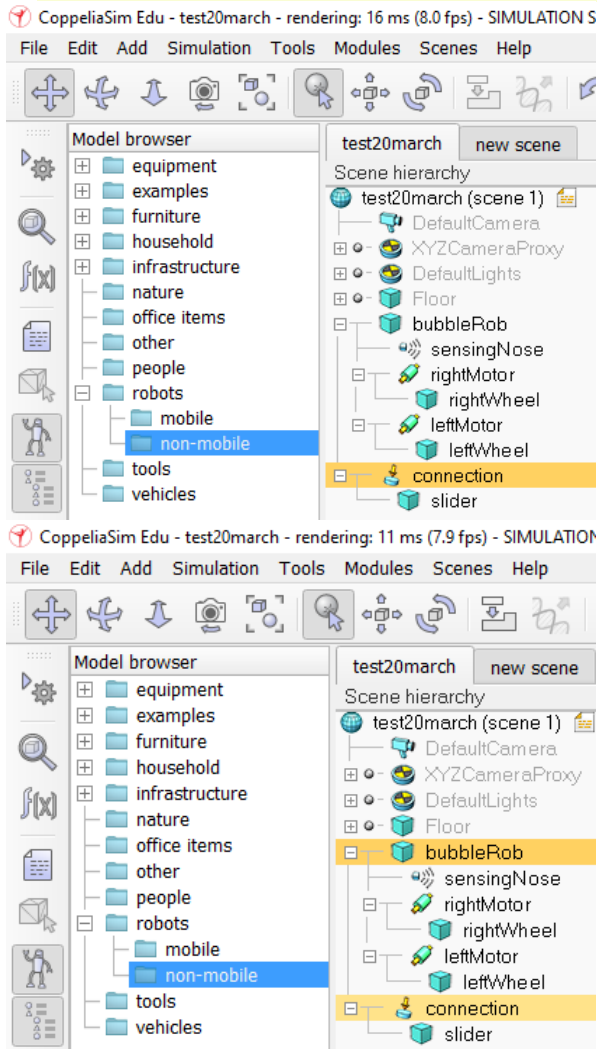
CoppeliaSim Edu - test20march - rendering: 13 ms (7.9 fps) - SIMULATION STOPPED



Select **connection** and click on **Position** dialogue



We select **connection**, then **control-select bubbleRob**, then click [Menu bar --> Edit --> Make last selected object parent].



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. 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:

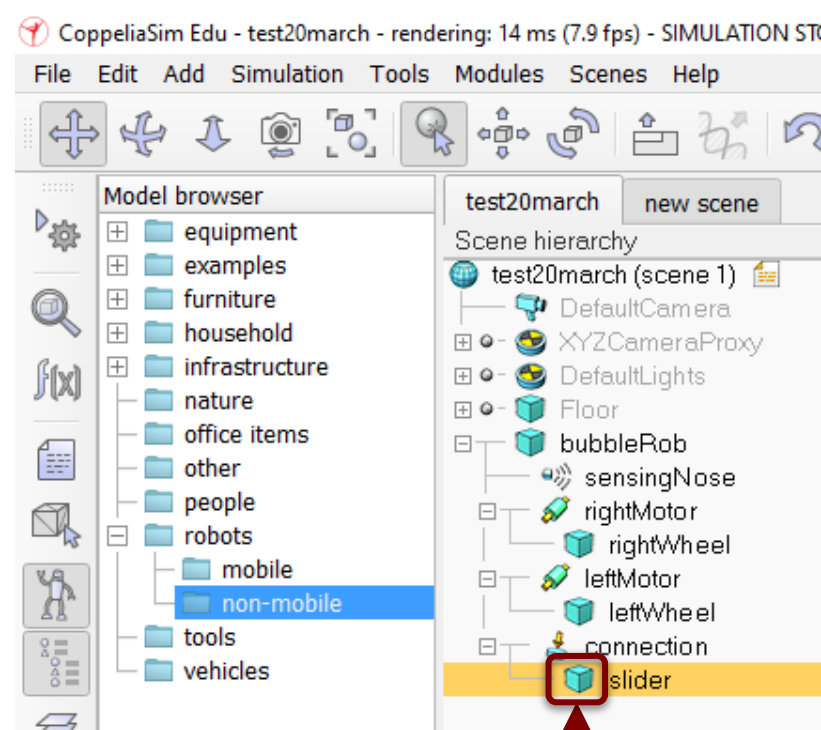
in the shape dynamics properties,

for **slider** we set the **local responsible** mask to **00001111**, and

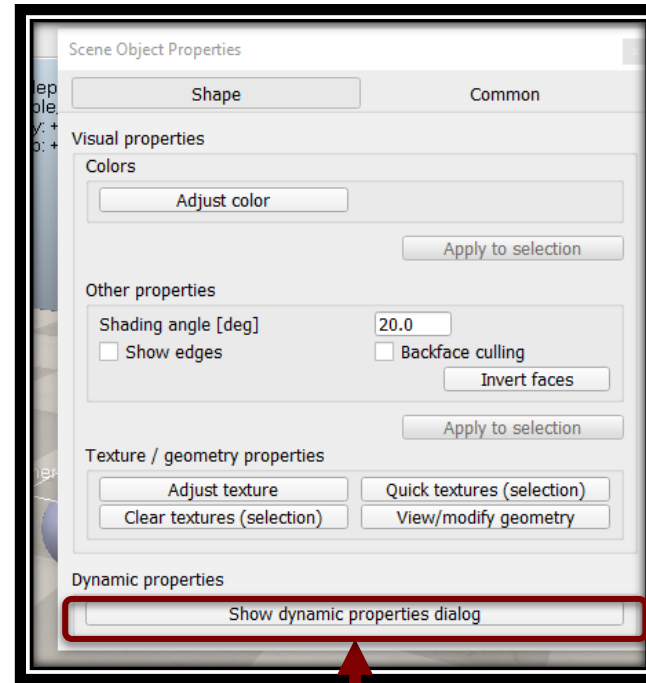
for **bubbleRob**, we set the **local responsible** mask to **11110000**.

STEP 22

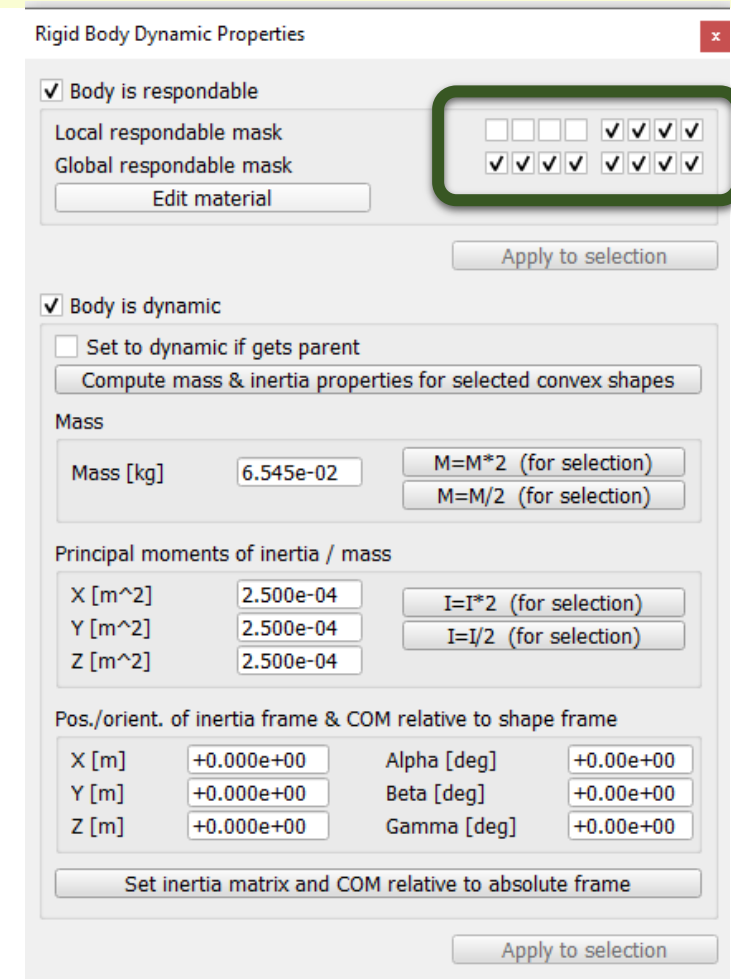
For slider we set the **local responsible** mask to **00001111**,



Double Click on
teal colour shape

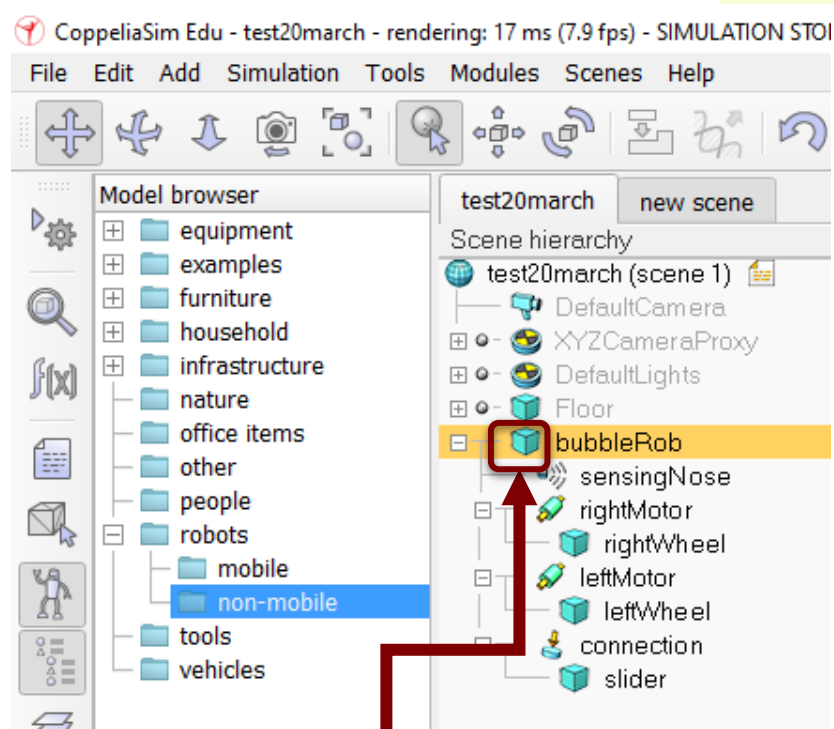


Click on this

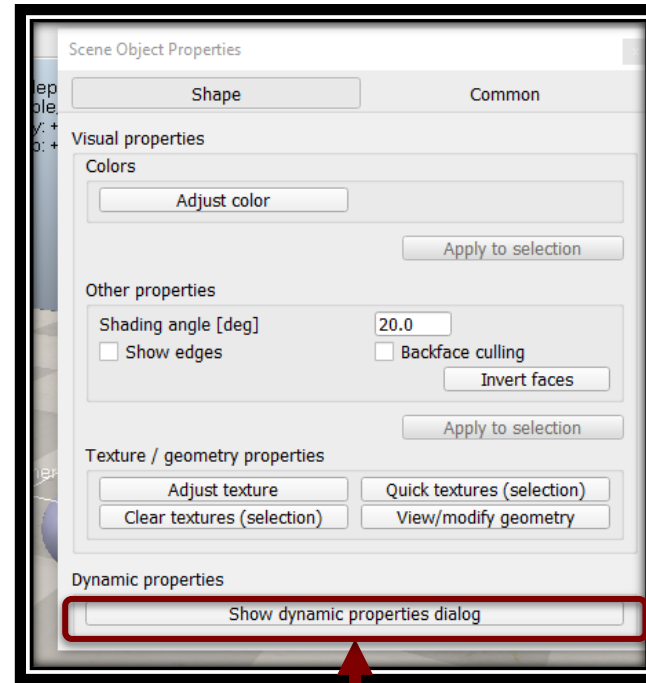


STEP 23

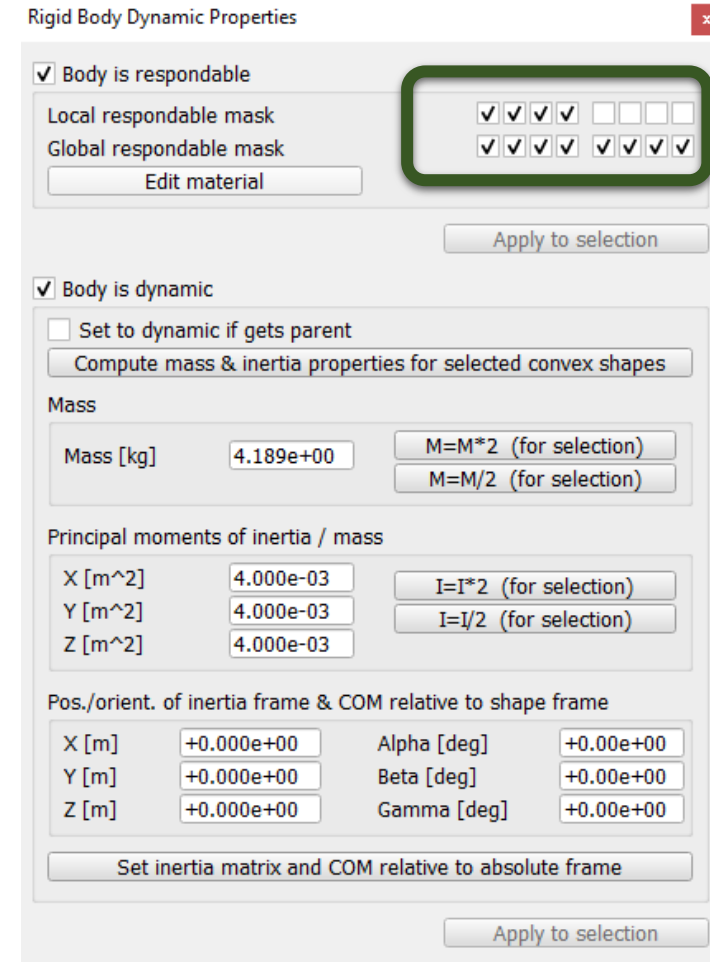
For **bubbleRob**, we set the **local responsible** mask to **11110000**



Double Click on
teal colour shape



Click on this



We run the **simulation again** and notice that **BubbleRob slightly moves, even with locked motor.**

Stability of dynamic simulations is tightly linked to **masses and inertias** of the involved non-static shapes.

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).*

STEP 24

Select the two wheels and the slider, and in the shape dynamics dialog we click **three times** $M=M*2$ (for selection).

CoppeliaSim Edu - test20march - rendering: 10 ms (7.9 fps) - SIMULATION STOPPED

File Edit Add Simulation Tools Modules Scenes Help

Model browser

- equipment
- examples
- furniture
- household
- infrastructure
- nature
- office items
- other
- people
- robots
- mobile
- non-mobile
- tools
- vehicles

new scene test20march

Scene hierarchy

- test20march (scene 2)
 - DefaultCamera
 - XYZCameraPro
 - DefaultLights
 - Floor
 - bubbleRob
 - sensingNose
 - rightMotor
 - rightWheel
 - leftMotor
 - leftWheel
 - connection
 - slider

Tools Modules Scenes Help

- ☒ Scene object properties
- ☐ Dynamics properties
- ☐ Scripts
- ☐ Environment
- ☒ Model browser
- ☒ Scene hierarchy
- ☐ Layers
- ☐ Video recorder
- ☐ User settings

Scene Object Properties

Shape Common

Visual properties

Colors

Adjust color

Apply to selection

Other properties

Shading angle [deg] 20.0

☐ Show edges ☐ Backface culling

Invert faces

Apply to selection

Texture / geometry properties

Adjust texture Quick textures (selection)

Clear textures (selection) View/modify geometry

Dynamic properties

Show dynamic properties dialog

Rigid Body Dynamic Properties

☒ Body is responsible

Local responsible mask ☐ ☐ ☐ ☒ ☒ ☒ ☒ ☒

Global responsible mask ☒ ☒ ☒ ☒ ☒ ☒ ☒ ☒

Edit material

Apply to selection

☒ Body is dynamic

☐ Set to dynamic if gets parent

Compute mass & inertia properties for selected convex shapes

Mass

Mass [kg] 5.236e-01

$M=M*2$ (for selection)

$M=M/2$ (for selection)

Principal moments of inertia / mass

X [m^2] 2.500e-04 $I=I*2$ (for selection)

Y [m^2] 2.500e-04 $I=I/2$ (for selection)

Z [m^2] 2.500e-04

Pos./orient. of inertia frame & COM relative to shape frame

X [m] +0.000e+00 Alpha [deg] +0.00e+00

Y [m] +0.000e+00 Beta [deg] +0.00e+00

Z [m] +0.000e+00 Gamma [deg] +0.00e+00

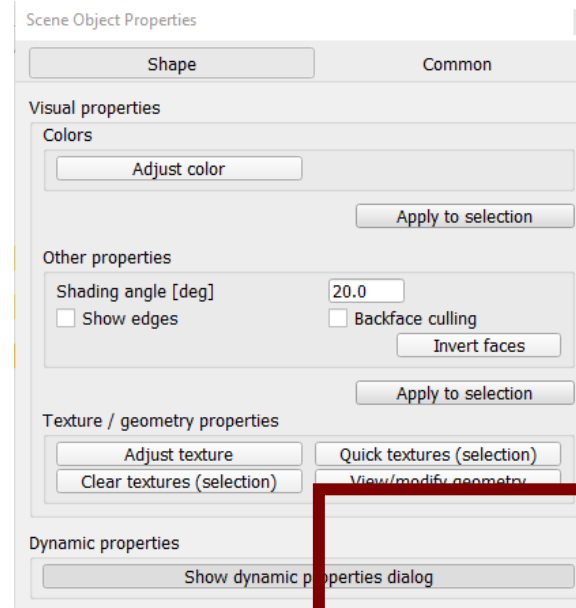
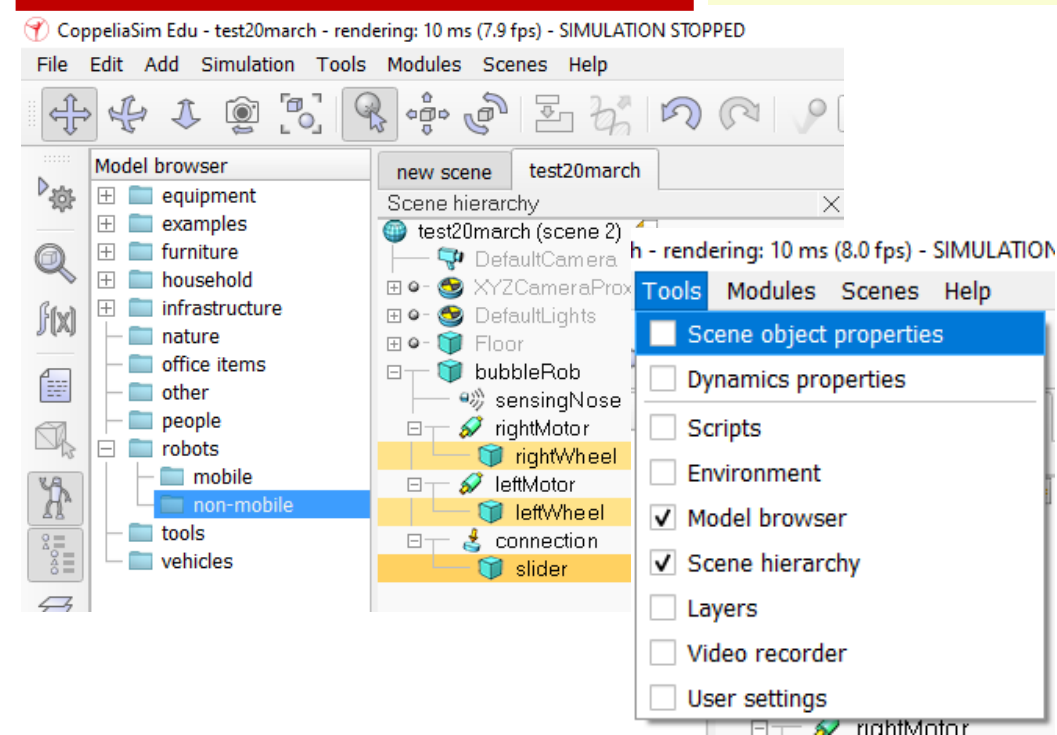
Set inertia matrix and COM relative to absolute frame

Apply to selection

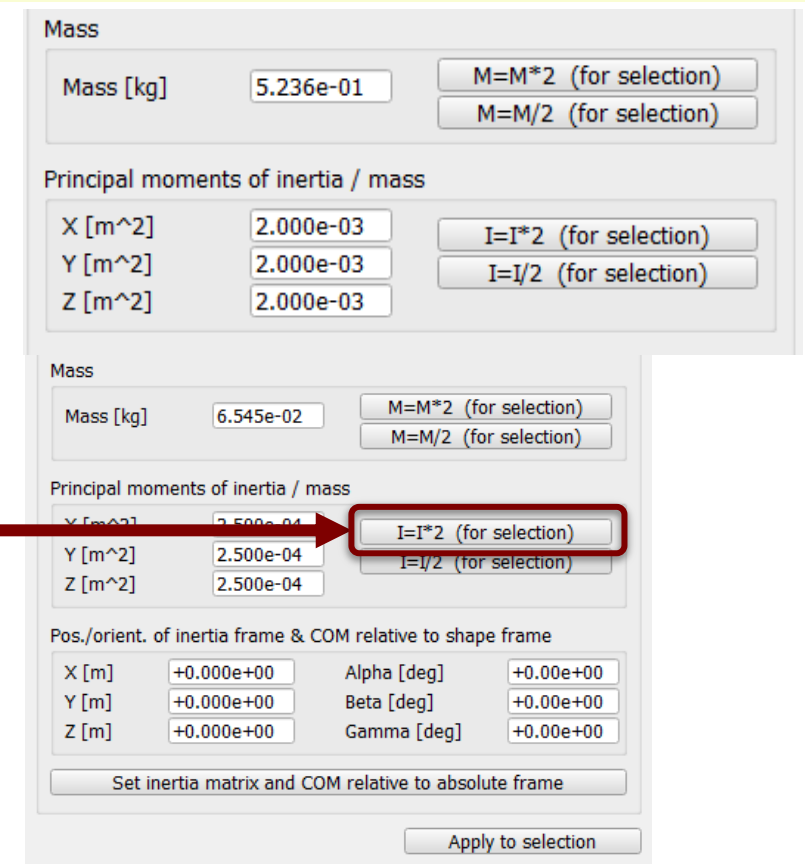
Click on this 3 times

STEP 25

Repeat the step for Inertia. Select the two wheels and the slider, and in the shape dynamics dialog we click **three times** $I=I*2$ (for selection).

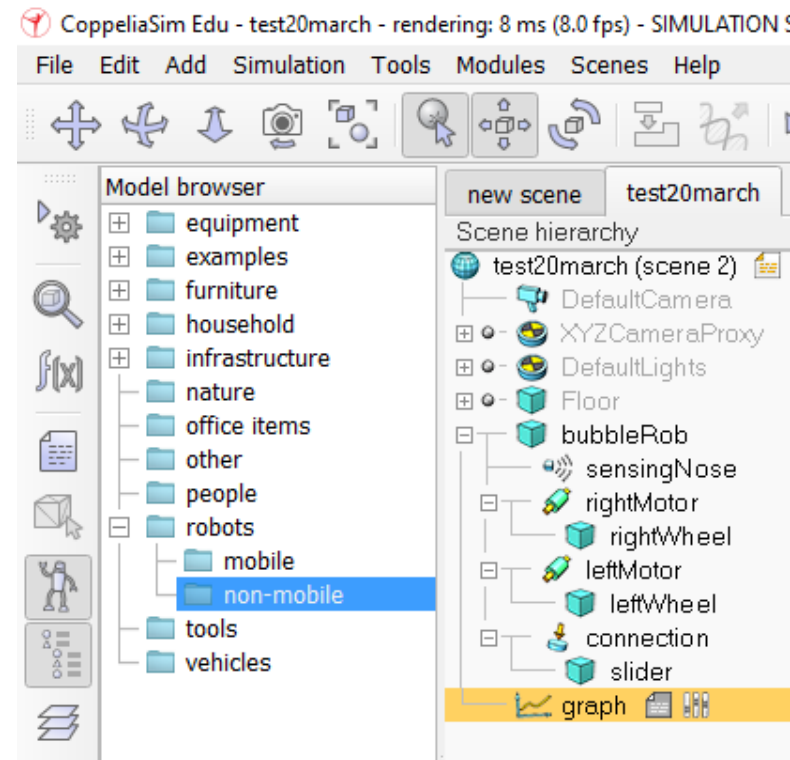
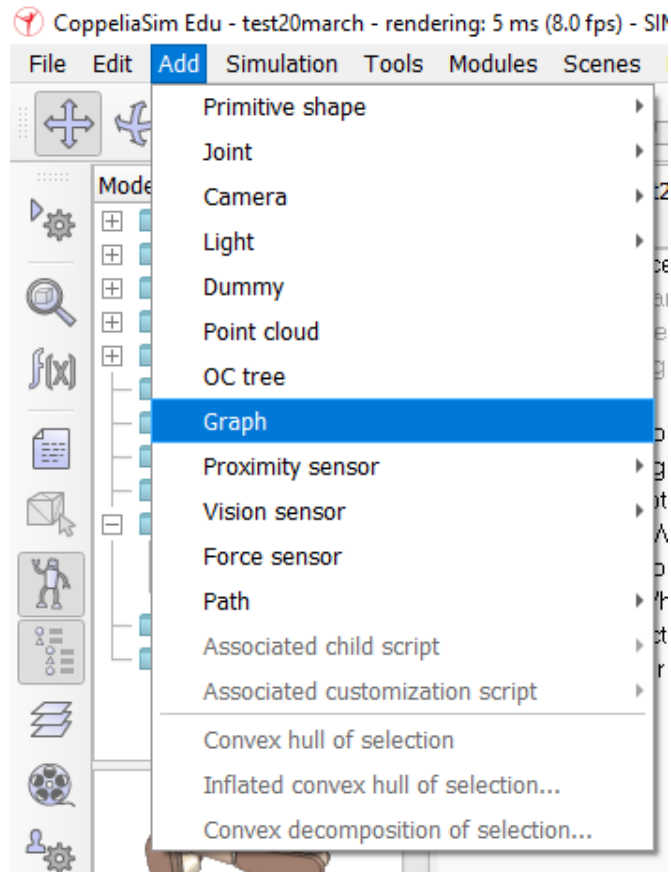


Click on this
3 times



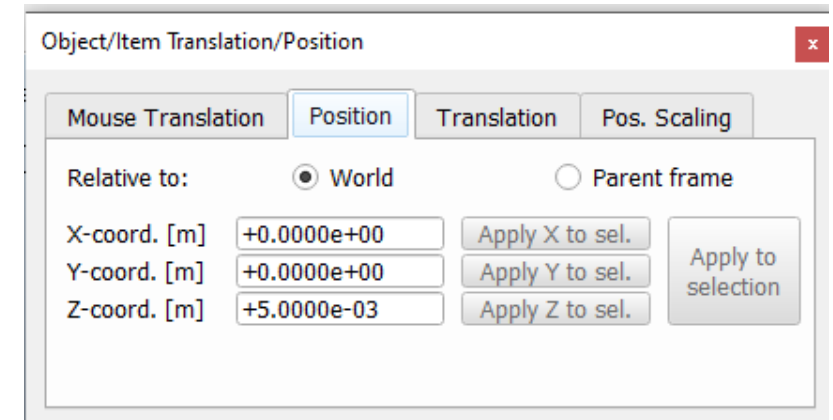
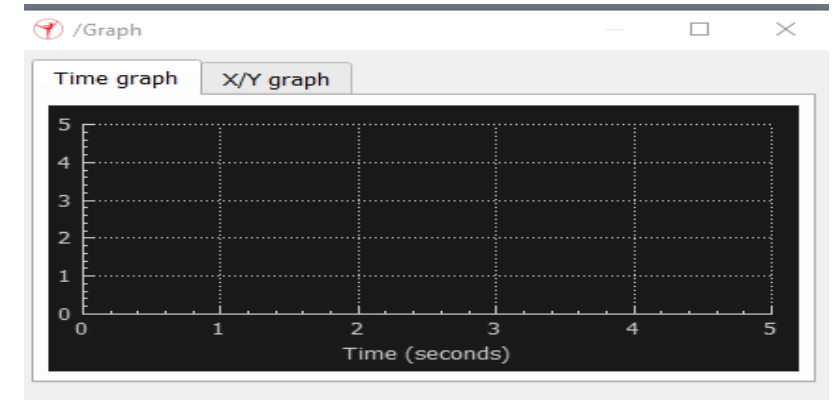
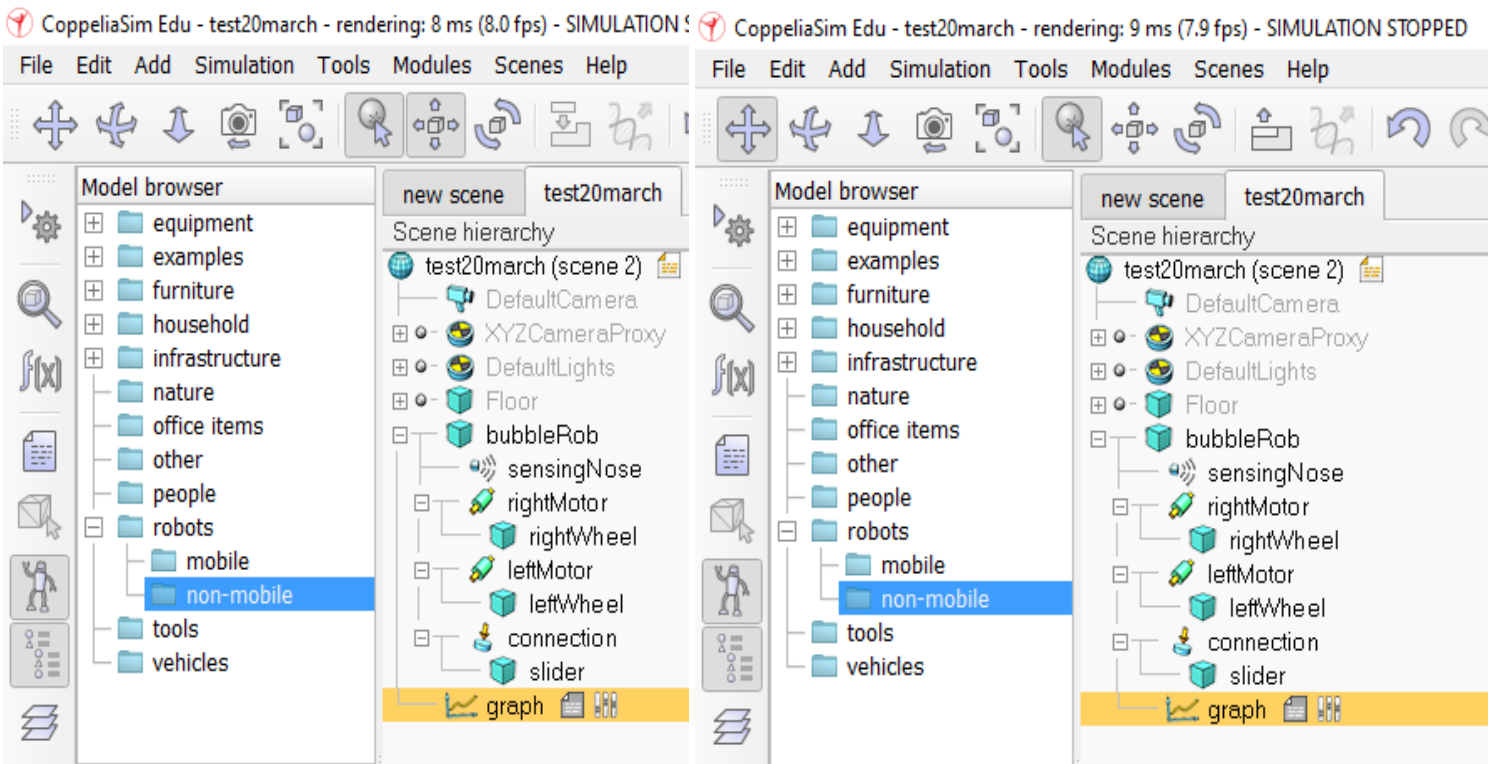
STEP 26

Add a **graph object** to **BubbleRob** in order to display its clearance distance. We click **[Menu bar --> Add --> Graph]** and rename it to graph.



STEP 27

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).

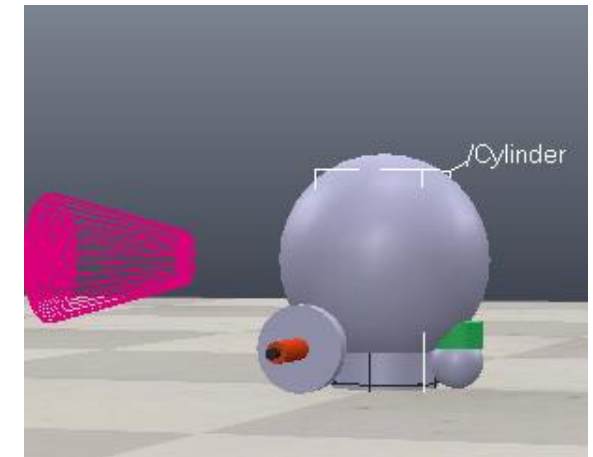
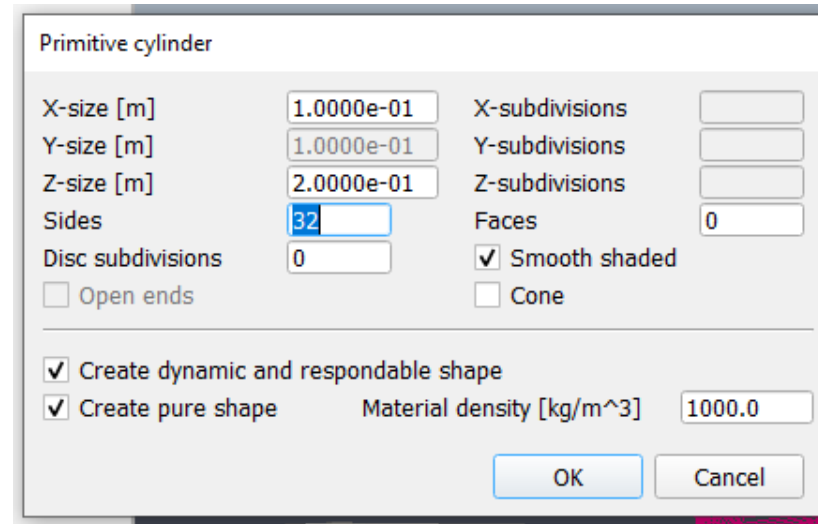
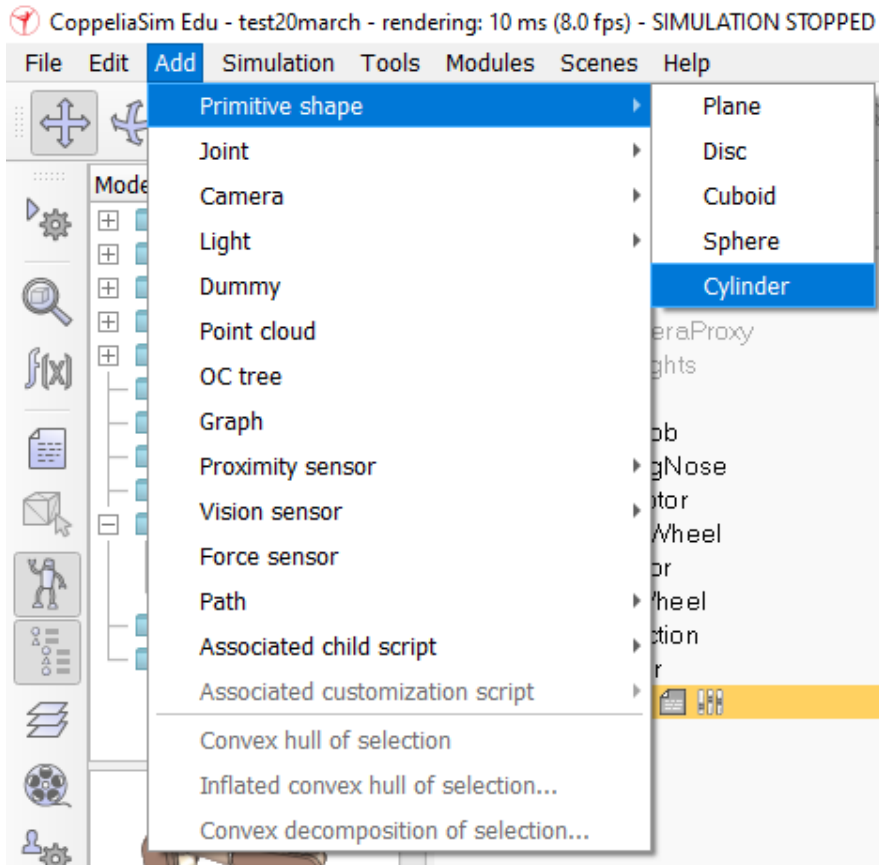
We want this **cylinder to be static** (i.e. not influenced by gravity or collisions) but still exerting some collision responses on non-static respondable shapes.

For this, we **disable Body is dynamic** in the **shape dynamics properties**.

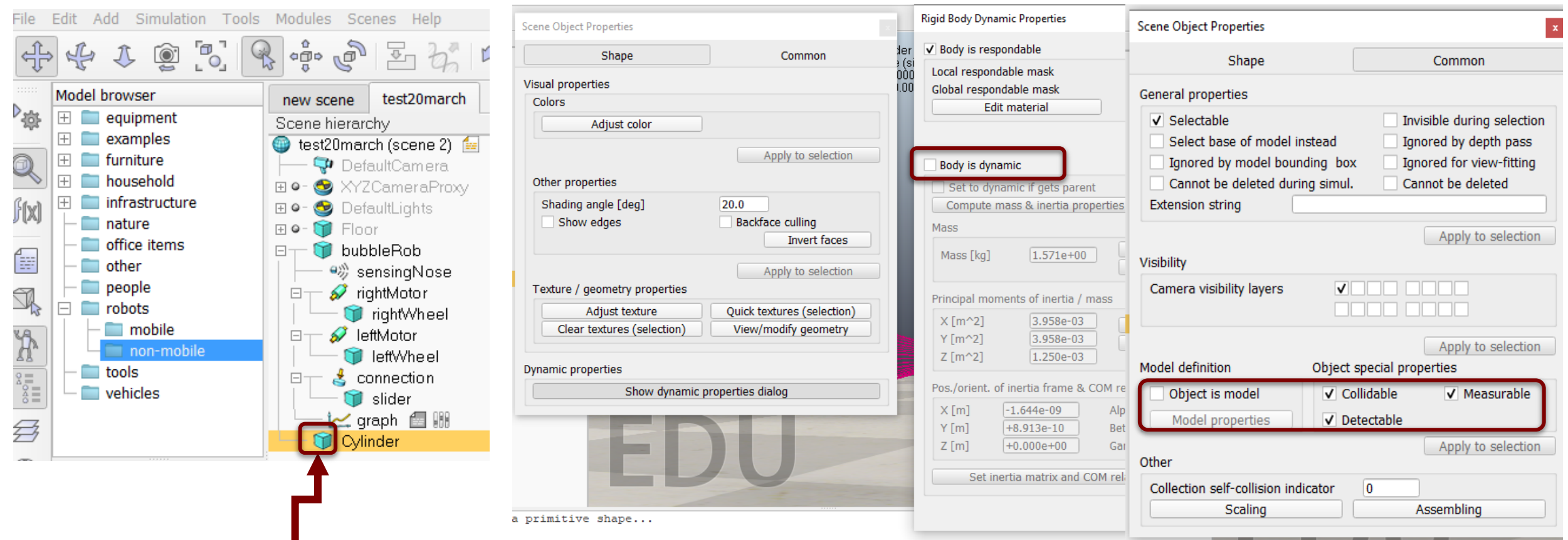
We also want our cylinder to be **Collidable, Measurable and Detectable**.

STEP 28

We add a pure primitive cylinder with following dimensions: (0.1, 0.1, 0.2).



Disable Body is dynamic in the shape dynamics properties.
We also want our cylinder to be Collidable, Measurable and Detectable.

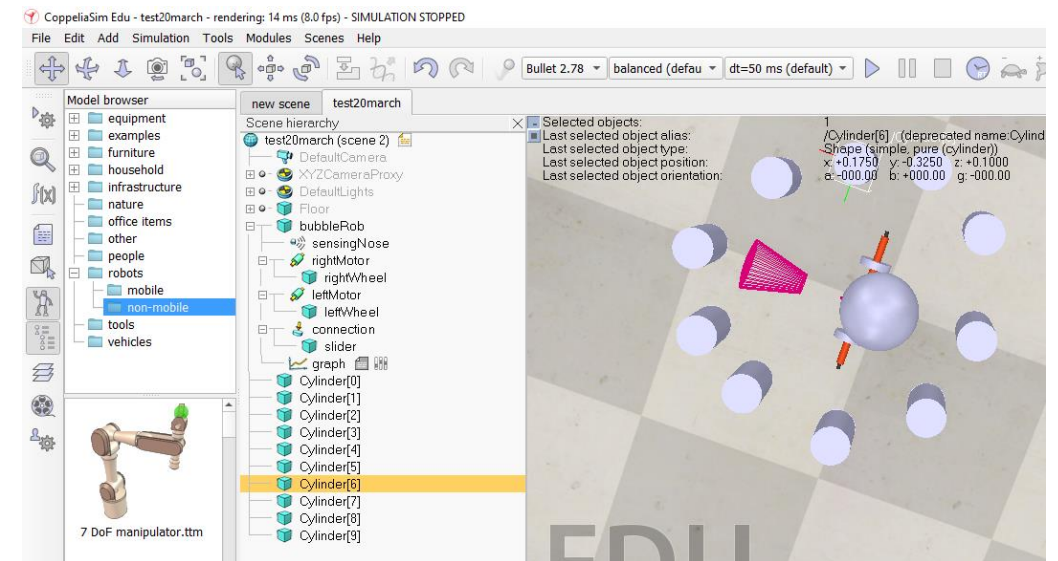
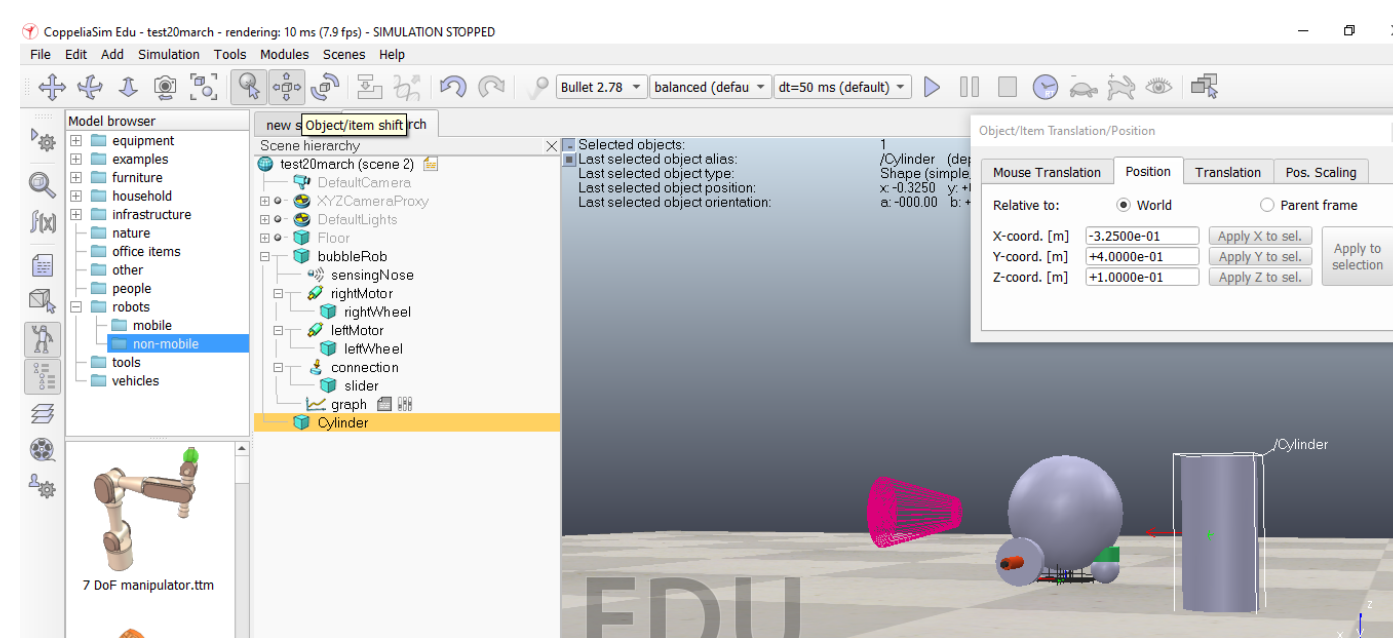


**Double Click on teal
colour shape**

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.

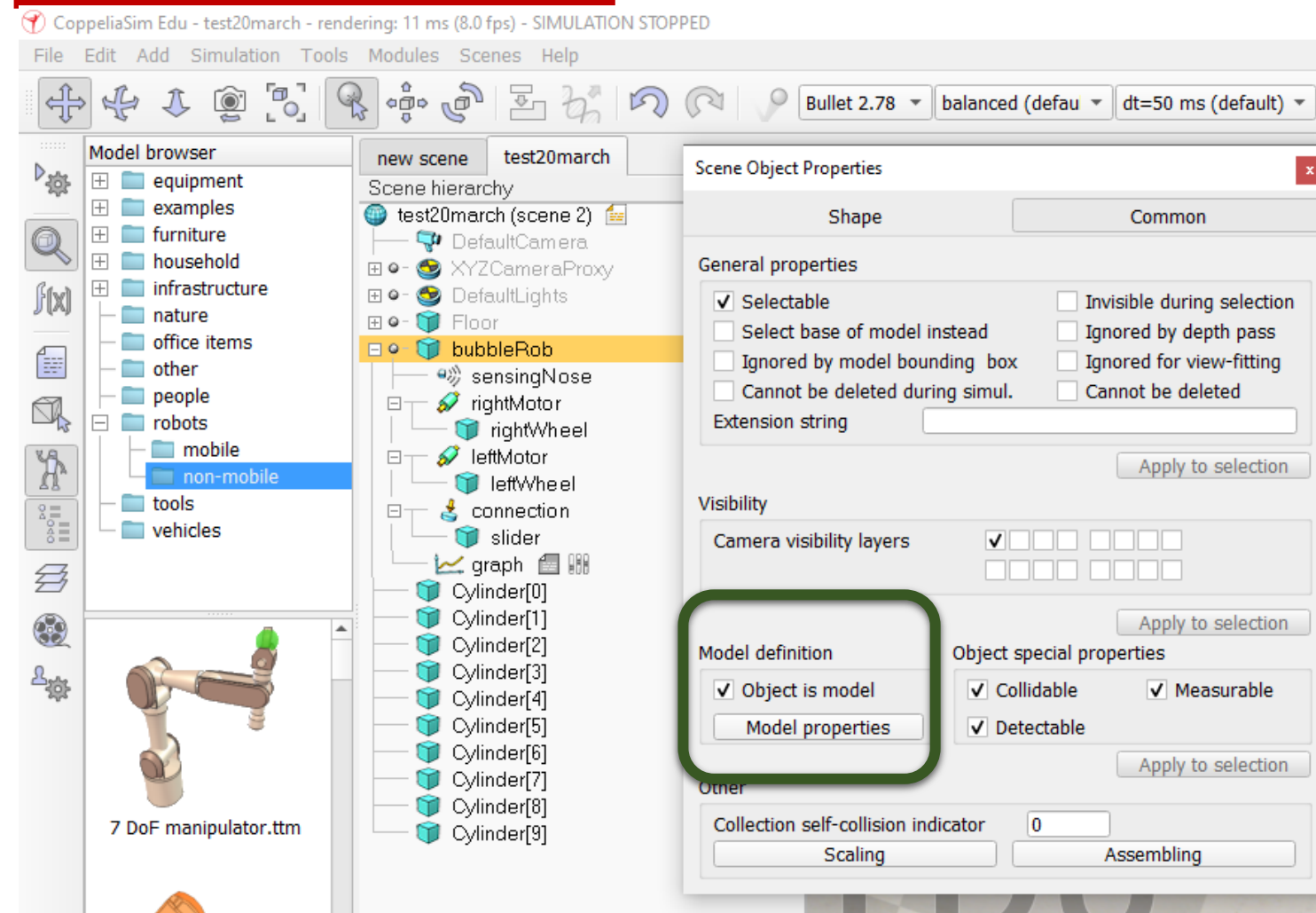
We copy and paste the cylinder a few times, and move them to positions around BubbleRob.

- 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:



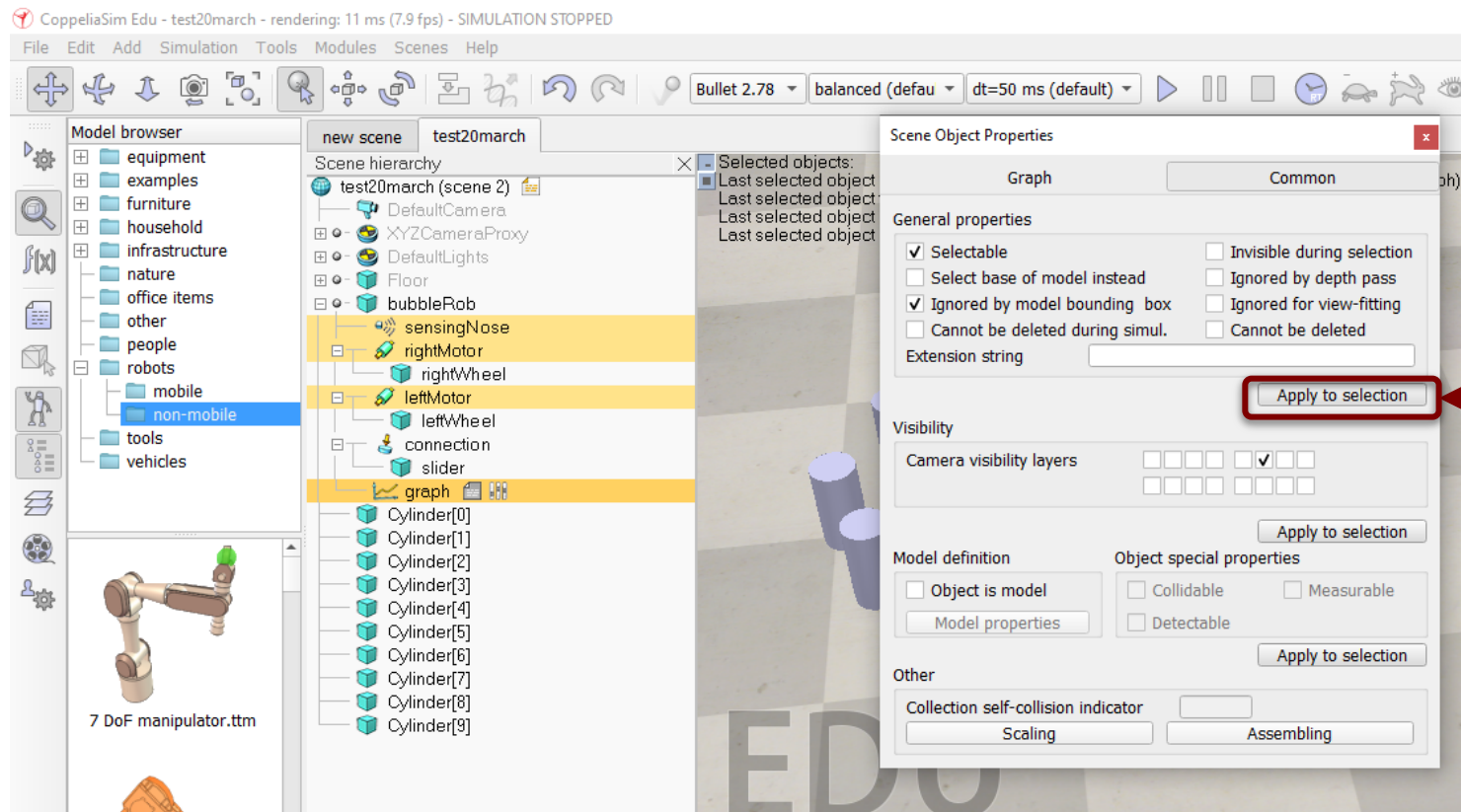
STEP 29

We now need to finish **BubbleRob** as a **model** definition.



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.



Click on this



prashant.e9437@cumail.in

Mb: 9411047357

*Thank
You!*