

Lunar Scout: Task 2A Bike Design

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Oct 2023

Aim:

- In this Task you'll design your own Lunar Scout Bike model in CoppeliaSim with the help of certain existing models that we will provide.
- The bike will use **an Omniwheel** and a normal drive wheel.

We hope you have got a good introduction about CoppeliaSim now, because here it will be used extensively.

Deadline for 2A is shorter than 2B/2C. Also *2B/2C are dependent on this task*, so you should attempt to **complete Task 2A first**. Also

Download the **Task2A.zip** file from here. The contents of this ZIP file are as follows:

- Task_2A.ttt
- COM_tool.ttm

Steps:

- 1 . Create bike's body or chassis from primitive shapes - according to the BEST MASS DISTRIBUTION as per your intuition. **Decide what type of mass distribution will be helping bike balance easily in future tasks.**
2. Group all shapes you used for body & convert into single compound object - **"bike_respondable"**
3. Create Parent-Child Relationship in given hierarchy in Task_2A.ttt scene to complete the bike. RUN simulation & check if it works(**No error & parts stay joined, still movable**).

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4. Create a **Visual design of bike chassis(without wheels) in CAD software** → then **IMPORT** it in **CoppeliaSim** & add as child object in hierarchy. **Change visual properties of bike**
5. Export as the bike hierarchy as re-usable model with the extension as **“.TTM”**

Details & RULES :

- There are few **pre-made objects provided in Task_2A.ttt**. These should **NOT BE REMOVED** or manipulated. They should be a part of hierarchy without a change.

Following is the list of elements provided and their uses:

The elements highlighted in **yellow** are to be added by participants.

NAME	OBJECT TYPE	USAGE	
reference_frame	primitive shape	In future, for orientation feedback	
spherical_joint	JOINT(free)	connecting joint for required Degree of Freedom	
bike_respondable	primitive compound shape	GROUP of primitive shapes making bike body	To E
front_motor	JOINT(velocity)	Motor for controlling Omniwheel/Yaw Angle	DO N
omniwheel_sphere	primitive shape	Omniwheel respondable part	
roller	JOINT(free)	connecting joint for required Degree of Freedom	
roller_sphere	primitive shape	Omniwheel Roller respondable part	
omniwheel_visual	simple shape(imported mesh)	Omniwheel visual part	
drive_motor	JOINT(velocity)	Motor for driving forward/backward	DO N
drivewheel_sphere	primitive shape	Drive-wheel respondable part	
drivewheel_visual	simple shape(imported mesh)	Drive-wheel visual part	
bike_visual	simple shape(imported mesh)	Massless, non-dynamic visual overlay of bike	To

Table 1: List of elements in Task_2A.ttt

Design Restrictions:

- Do not edit or change any properties of the elements mentioned in the table above.**
- The Bike that you will build should **only use Omniwheel** based balancing.(algorithm will be completed in next task 2B)
- “Bounding box”** is a virtual cuboid which specifies the maximum permissible dimensions of the Bike : length x height x width (**30cm x 20cm x 10cm**)

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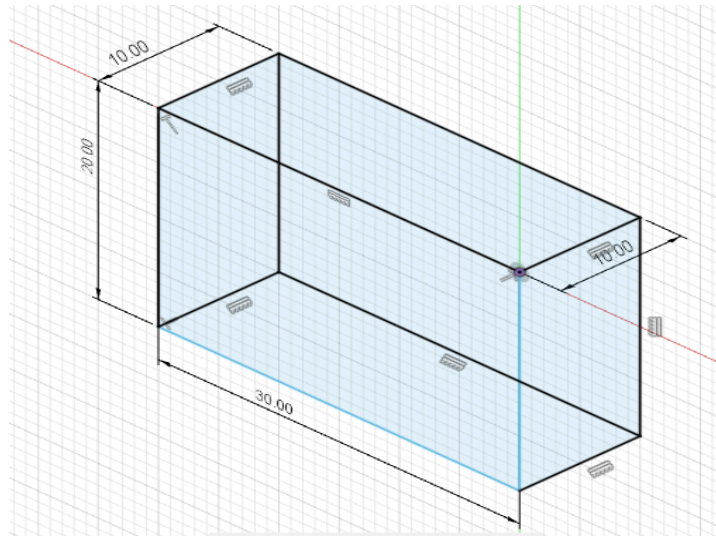


Figure 2: Bounding Box of Lunar Scout Bike

- The maximum permissible total weight of whole model is **1.5kg**.
- **Points of contact with ground (2 max.)** : Bike should have only two elements touching the ground i.e. the front and rear(drive) wheel.
- For primitive shape like cuboid, sphere, cylinder etc. the center of mass is at it's geometric center. But for primitive compound shape(Grouped primitive shape) it is not same. You can see Geometric center where **local/object frame axes in red, blue, green** are visible inside object.
- Center of Mass of **“bike_respondable”** should be at **$\geq 2.5\text{cm}$ height from the floor**(world coordinate).
 - To find the center of mass of the model, we have given a tool to visualize **“COM_tool.ttm”** in the downloaded folder. It will show the global position of center of mass and the value of total mass.
 - This tool works only with models, not objects. So for that first make sure that the Parent(Top-Most) Object of hierarchy is a **“model base”**. To make it a model base, **double-click** on the parent object(HERE : **“reference_frame”**) to open the Scene object Properties windows, then click on Common, and check Object is model base.

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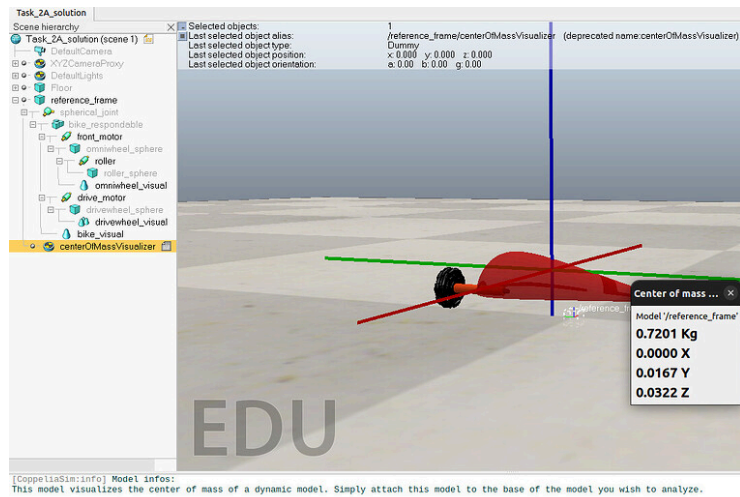


Figure 3: Visualizing Center of Mass

Coppeliasim Hierarchy

- Inside Coppeliasim on the left hand side you will find a block named Scene Hierarchy, on expanding the block you can look at the arrangement of components present, this arrangement defines the hierarchy or parent child relationship.

Important Note:

Make sure that this hierarchy is set up **as it is**, including the **naming convention**.

Hierarchy description:

(You can also refer to Figure 4)

- reference_frame
 - spherical_joint
 - bike_respondable
 - front_motor
 - omniwheel_sphere
 - roller
 - roller_sphere
 - omniwheel_visual
 - drive_motor
 - drivewheel_sphere
 - drivewheel_visual
 - bike_visual

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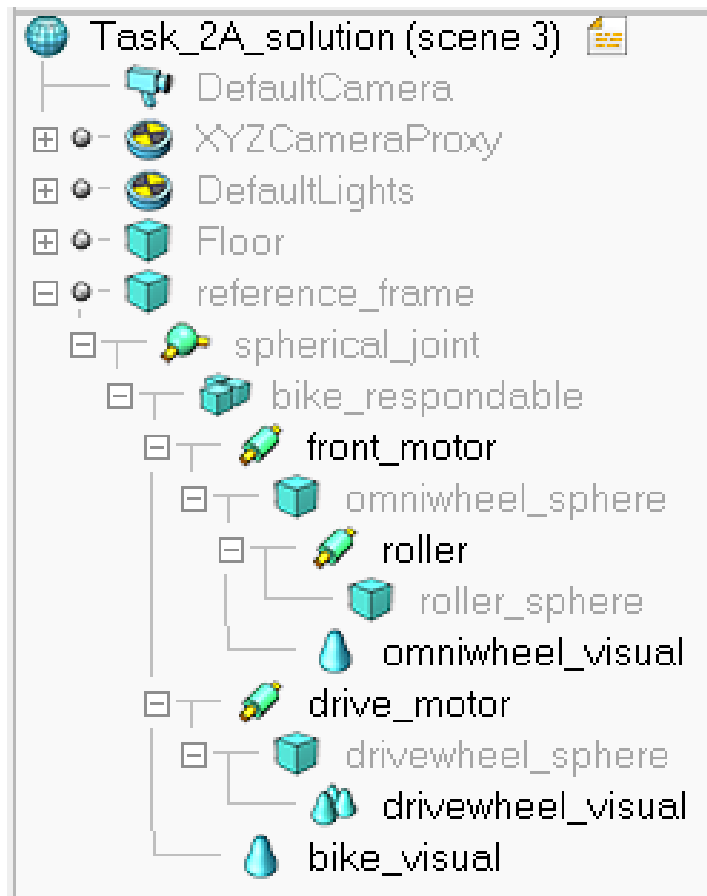


Figure 4: CoppeliaSim Hierarchy

Chassis Design

- The main objective here is to design the chassis using only **primitive shapes** in CoppeliaSim.
(There are other types of shapes like compound shapes etc. available - but *they make the dynamics tough to calculate for physics engine & hence errors and unpredictability may happen*. Hence, it's suggested **NOT TO USE other shapes** .)

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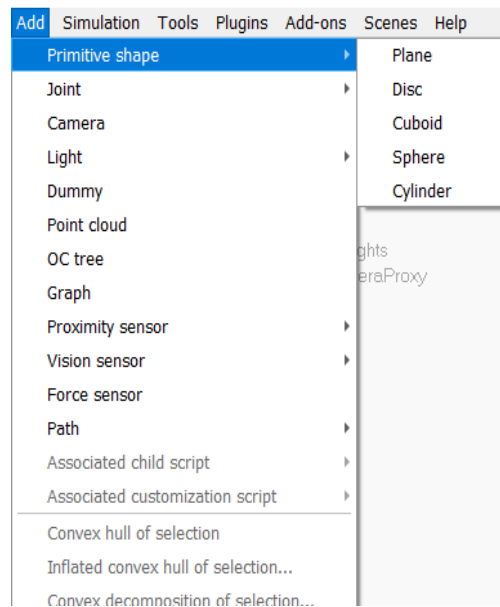


Figure 5: Primitive Shape menu in Coppeliasim

Refer the following to learn how to use simple shapes:

Refer the following Video to learn how to **GROUP primitive shapes**:

(But Remember : **DO NOT MERGE** as it is different operation & not recommended)

Designing Visual Skin of Bike using CAD

Before this step, we hope that you have created the bike's model in Coppeliasim. Now your bike is functional!!

Going further, let's take this chance to give good looks to our bike so that it looks **like a real LUNAR SCOUT** in your imagination and also learn a very important skill - **3D CAD design!**

You are free to choose a simplistic design if you find CAD difficult. Do not take much load here. But yet it will be a (small)part of your task grades

No restrictions on CAD software :

You can use any one that you find comfortable with. For example: **Solidworks, Fusion360, FreeCAD etc..** Just the submission files should be in proper format as required.

We suggest Fusion 360 as it's easy to start with...

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Autodesk Fusion 360 as an option:

- Watch this video to Install Fusion 360 (Education license):-
[Fusion 360 Installation | Education License](#)
- Refer to the following video, to understand **how to design and import mesh into CoppeliaSim** via Autodesk Fusion360.

NOTE: This video talks in reference to an older theme called Dairy Bike. So please ignore any details mentioned related to any task in this video, as there are difference between the two themes.

- However you can design the visual aspects in Fusion 360.
- Important point to understand here is that Visual aspects will be added as **non-dynamic** and **non-responsible** objects so they won't affect your RTF (Real Time Factor)

The making of complete Bike

- The chassis(**bike_responsible**) will act as a connecting element to the different components we have provided.

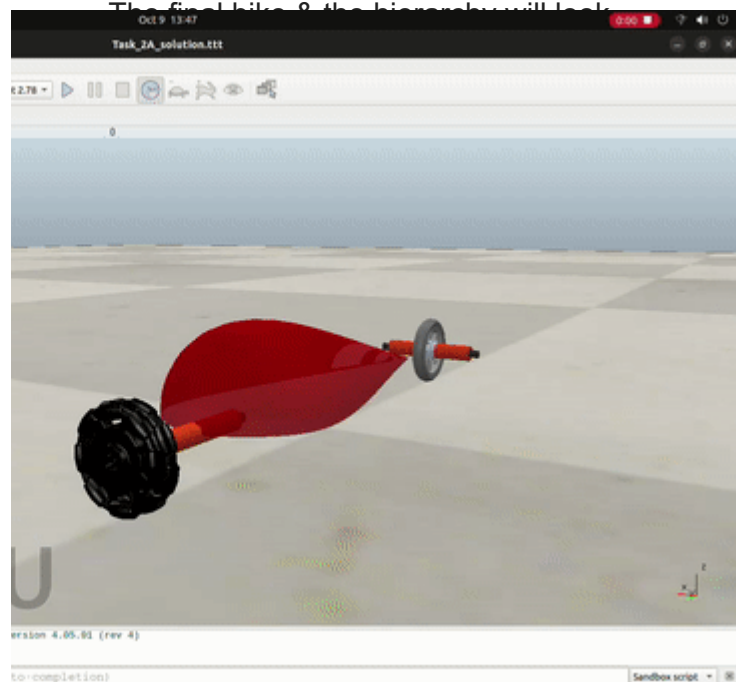


Figure 6: Bike Model Visual Properties in CoppeliaSim

Exporting as CoppeliaSim **Model File (*.TTM)**

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- First make sure that the Parent(Top-Most) Object of hierarchy is a “**model base**”. To make it a model base, **double-click** on the parent object(HERE : “**reference_frame**”) to open the Scene object Properties windows, then click on Common, and check Object is model base.
- Click on “model base” → You can now do : File → Save model as... follow the instructions until the end...
- To make it appear in the Model browser, just put your .ttm file under the model folder of CoppeliaSim
- It's ready to be re-used !!! Try dragging & dropping it in any blank scene !!!

Task Submission (ONLY 2 submission ALLOWED!!)

This task will be manually evaluated.

NOTE :

1st Submission : will be reviewed and **you will get FEEDBACK comments to improve**. Do not submit 2nd one before 1st feedback.

2nd Submission : will be **evaluated ONLY AFTER THE DEADLINE**. Which is Final and only 1 allowed.

MAX SCORE = 10

- For successful completion of **Task 2A** , upload the model file **Task_2A.ttm** file on the portal.

Remember “*.ttt” is a scene file & “*.ttm” is a model file. Both are different. You need “*.ttm” here!

- Click on this link: https://portal.e-yantra.org/task_task2 . In the **Task 2 Upload** section, click on **Task 2A** bullet and select **Choose file** button to upload the **Task_2A.ttm** file.
-From the dialogue box, select the file and click **Open**.
- You shall see the file name **Task_2A.ttm** in text-box besides the **Choose file** button. Click on **Upload Task** button to submit the file.

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That's it !! Task 2A is complete!!

Congrats!!

[🔗 Lunar Scout: Task 2](#)

Closed on Oct 10, 2023

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