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Assignment 5: A model of our Solar System with the 6 inner planets

The task in this assignment is to write a 3D model of the inner solar system, consisting of the Sun and the planets Mercury, Venus, Earth (including the Moon) and Mars, Jupiter and Saturn (including the ring system). See section 2 for the relevant data. The moons of Mars, Jupiter and Saturn will be neglected.
The challenge for such a model is to deal with the different length scales. For instance, the distance of the sun to the earth is several millions times the radius of the earth. Similarly, though less dramatic, the radius of the sun is more than 100 times larger than the radius of the earth. A model that looks interesting cannot maintain these length ratios.

1 Requirements

The model of the inner solar system should contain the following elements:

1. As background create a sky box with the images in the `MilkyWay` folder.
2. Place a white point light source at the center of the sun.
3. All planets and the sun should be modelled as spheres with textures applied. For the earth us all textures provided: surface, clouds, specular map and normal map. For the moon apply both the provided texture image and the bump map.
4. The planets move on circular orbits around the Sun. All these orbits lie in the same plane. This plane is called ecliptic. The radii of these orbits are given in the *Distance to Sun* column of the table in section 2. The periods of the orbits are given in the *Length of year* column.
5. All objects rotate around their axis of rotation, which is tilted with respect to an axis perpendicular to the ecliptic by the angle given in the *Axial tilt* column. The period of this rotation is given in the *Length of day* column.
6. The Moon orbits around the Earth as well as around its own axis. The orbit lies in the same plane as the other planet's orbits. See section 2.1 for the data.
7. Use the `dat.gui` library (see section 3) to add a slider which sets the duration of an Earth day in simulation seconds to a value between 0.1 and 200 seconds with an initial value of 5 seconds.
8. Model the earth radius as a variable whose value can be changes with a slider between 0.2 and 3 with an initial value of 1. Scale all other planet radii accordingly.
9. Set the distance from the sun to the earth (which is called an astronomical unit) to a value of 20. Scale all other orbits accordingly.
10. The sun is too big to be represented realistically. Scale down its radius down to x% of its original radius. Add a slider allowing to change x between 1% and 10%. Give the sun a yellow to orange emissive color.

11. Add a checkbox to the dat.gui to indicate whether the planet orbits are shown.
12. Add a ring to the planet Saturn with the correct tilt and a texture applied. See section 2.1 for the ring dimensions.
13. Make sure that
    - the ratio of the planet orbits,
    - the ratio of the planet radii,
    - the ratio of the planet day lengths,
    - the ratio of the planet year lengths

    are always correctly maintained.
14. Rotate the solar system or the skybox such that the ecliptic and the band of the Milky Way are correctly aligned.
15. Use Javascript modules to load the Javascript code.

2 Solar system data

2.1 Sun and 6 inner planets

The following table collects some planet data useful for the solar system model. The first four columns are specified relative to the Earth. For instance, Mercury takes 58 Earth days to complete one rotation around its own axis whereas it takes 0.24 Earth years to rotate around the Sun.

	Radius	Distance to Sun	Length of day	Length of year	Axial tilt (degree)
Sun	110	–	25	–	7.3°
Mercury	0.38	0.39	58	0.24	0°
Venus	0.95	0.72	240	0.62	3°
Earth	1	1	1	1	23.5°
Mars	0.53	1.5	1.03	1.88	25.2°
Jupiter	11.2	5.2	0.41	11.8	3.1°
Saturn	9.4	9.5	0.45	29.5	26.7°

All rotations are counter-clockwise with the exception of the axial rotation of Venus which is clockwise.

The Moon

Distance to Earth	0.003× Distance Earth-Sun
Radius	0.27× Radius of Earth
Period of rotation around Earth	27.3 days
Period of rotation around axis	27.3 days
Axial tilt	6.68°

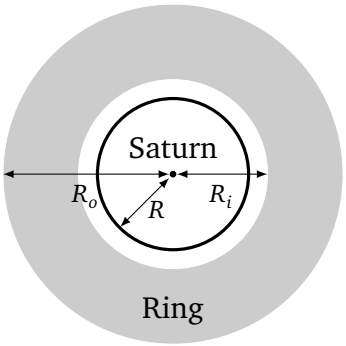
The Saturn rings

The saturn rings are tilted with respect to the ecliptic by the same angle as the axis of rotation of Saturn.

The ring dimensions are:

$$\text{Inner ring radius } R_i = 1.25 \times R$$
$$\text{Outer ring radius } R_o = 1.25 \times R$$

where R is the radius of Saturn.



3 The `dat.gui` library

This is a little library that can be used to add simple parameter controls to a web page. It is provided in the file `dat.gui.module.js` in the `moduleLibs/build/` directory.

- Documentation: https://workshop.chromeexperiments.com/examples/gui
- Github: https://github.com/dataarts/dat.gui

4 Coding style

- Stick to the coding style guide which can be found in the Readme file for chapter 3 in the gitlab repository.
- Load the `three.js` and everything else as a module.

5 Handing in the solution

No group work allowed. Every course participant has to write her or his *own* code!
Implement your entire solution within the two files `Assignment5.html` and `Assignment5.js`. Feel free to change these files as you like but do not add any further files.
The deadline for submission is the **25th of February 2021**.