Mixed Reality & Simulation

Solar System

WS 2023/24

Upload a zip-file with your name ss-[last name].zip (eg ss-konrad.zip) to moodle (Upload - Solar System (15 points)).

The zip-file should contain:

- Code-files containing your algorithm
- Protocol
- Short video

Assessment:

- Functionality/celestial bodies (2 points)
- Physics calculations (4 points)
- System configurations/parameters (2 points)
- Time measurement (2 points)
- Protocol (Screenshots, description of project, physics, parameters & time table) (3 points)
- Video (2 points)

Functionality:
Create your own solar system by creating the eight planets, orbiting the sun. Also include the moon orbiting earth. The sun should be located in the center at the coordinates (0, 0, 0). The sun should not move during the simulation (be aware when applying forces to celestial bodies).

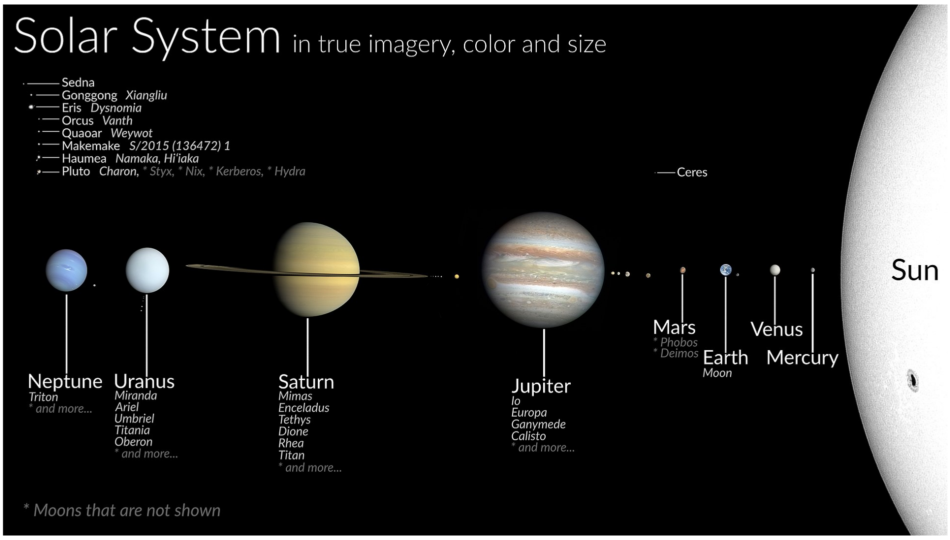

Figure 1: Solar System

The following table contains the data needed for the simulation: the radius of an object in km, the mass relative to the mass of earth, the distance to the sun in millions of kilometers, the time to orbit the sun in (earth) years. To create earth, you can just create a sphere with a scale of 6.3. To create your sun, just create a sphere with a scale of 696. When the sun is at (0, 0, 0,) you can place the earth now at (1510, 0, 0).

Solar System				
Celestial	Radius (km)	Mass (earths)	Distance to sun (million km)	Orbital period (Earth years)
Sun	696,342	333,000.000	-	-
Mercury	2,440	0.055	63.81	0.241
Venus	6,052	0.815	107.59	0.615
Earth	6,371	1.000	151.48	1.000
Mars	3,390	0.107	248.84	1.881
Jupiter	69,911	317.800	755.91	11.862
Saturn	58,232	95.160	1,487.80	29.457
Uranus	25,362	14.540	2,954.60	84.021
Neptune	24,622	17.150	4,475.50	164.800

Physics calculations :

To calculate the gravitational attraction between two bodies you can use Newtons law of gravity:

$$F = G * \frac{m1 * m2}{r^2}$$

m1... Mass object 1
m2... Mass object 2
r... Distance between the two bodies

G is called the gravitational constant and it's real value is

$$6.67 * 10^{-11}$$

but for simulation purposes you can use a value around **100**.

To avoid planets just falling into the sun, each planet needs an initial velocity. You can use an elliptical orbit or a circular orbit.

Stable circular orbit:

$$v = \sqrt{\frac{G * m2}{r}}$$

G... Gravitational constant
m2... Mass object 2 (sun)
r... Distance between the two bodies

System configurations/parameters:

- Zoom in/out (camera)
- Time adjustable/game speed
- Adjust gravitational constant

Time measurement:
Measure the time it takes for each planet to orbit the sun. Measure the time in relation to the earth. It takes one (earth) year for earth to orbit the sun. Compare your results with the the orbital period inside the table.

Documentation:
Create a short (∼ 2 pages) **protocol** containing a description of your solution and screenshots. How does your physics system work? Include the results of your time measurement in the protocol. What value did you use for your gravitational constant?
Create a short (∼ 1 min) **video** showing the planets orbiting the sun for a full (earth) year. Speed up the simulation or the video if necessary.