FYS3150
Project 3 -

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https://github.com/kryzar/Perseids.git

Abstract

Contents

Introduction

Chapter 1

Theory

In a first place, we will begin with an Earth-Sun system with the Earth orbiting around the Sun to test a simple algorithm and then we will add the other planets to have a simulation of the complete Solar System.

1.1 Earth-Sun system

1.1.1 Physical conditions of the system

The only force applied to this system is the gravity. According to the Newton's law, we have

$$F_G = \frac{GM_\odot M_\oplus}{r^2}$$

with F_G the gravitational force, G the gravitational constant ($G = 6.674 \times 10^{-11} N.m^2.kg^{-2}$), $M_\odot$ the mass of the Sun, $M_\oplus$ the mass of the Earth and r the distance between the Earth and the Sun.
We will neglect the motion of the Sun here as the mass of the Sun is much larger than the mass of the Earth ($M_\odot = 2 \times 10^{30}$kg against $M_\oplus = 6 \times 10^{24}$kg). We want to establish the motion of the Earth around the Sun. Moreover, we will assume that the orbit of the Earth around the Sun is coplanar in the xy-plane.

1.1.2

The Newton's second law of motion is given by $F = M \times a$ with F the force applied to the system, M the mass of the body concerned and a the acceleration. Applied to our case, we have $F_G = M_\oplus \times a$ which can be written in two equations :

$$F_{G,x} = M_\oplus \frac{d^2x}{dt^2}$$
$$F_{G,y} = M_\oplus \frac{d^2y}{dt^2}$$

or

$$\frac{d^2x}{dt^2} = \frac{F_{G,x}}{M_\oplus} \tag{1.1}$$

$$\frac{d^2y}{dt^2} = \frac{F_{G,y}}{M_\oplus}. \tag{1.2}$$

with $F_{G,x}$ and $F_{G,y}$ the components of the gravitational force.

We will not use the SI units but the Astronomical units (AU) for the distance (with 1AU=average distance Earth-Sun $= 1.5 \times 10^{11}$m) and years for time units.
In this case, the initial position of the Earth will be $x_\oplus = 1,\ y_\oplus = 0$ with the Sun the origin ($x_\odot = 0$, $y_\odot = 0$).

1.1.3

To simplify a little bit, we will assume that the Earth's orbit is circular around the Sun. So we can write :

$$F_G = \frac{M_\oplus v^2}{r} = \frac{GM_\odot M_\oplus}{r^2} \tag{1.3}$$

with v the velocity of Earth. From here we have

$$v^2 r = GM_\odot = 4\pi^2 \mathrm{AU}^3/\mathrm{yr}^2$$

1.2 Three-body problem

`http://ssd.jpl.nasa.gov/horizons.cgi#top`

1.3 The complete Solar system

Planet	Mass (kg)	Distance to the Sun (AU)
Mercury	3.3×10^{23}	0.39
Venus	4.9×10^{24}	0.72
Earth	6×10^{24}	1
Mars	6.6×10^{23}	1.52
Jupiter	1.9×10^{27}	5.20
Saturn	5.5×10^{26}	9.54
Uranus	8.8×10^{25}	19.19
Neptun	1.03×10^{26}	30.06

Chapter 2

Implementation

2.1 Earth-Sun system

2.2 Adding one planet

2.3 The complete Solar system

Chapter 3

Results

3.1

3.2

3.3

Conclusion

Bibliography

- NASA website http://ssd.jpl.nasa.gov/horizons.cgi#top
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