

TP Animation 3D 6

Influence of algorithm : double pendulum

6.1 Objectives

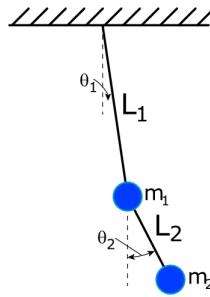
We will see how the choice of algorithm, and how computations are made, may change the behaviours of system. More precisely in this work, integrators will be tested.

6.2 What we will study

A double pendulum! A double pendulum is just a pendulum, with another pendulum attached to its end. You can have an idea on this site : http://www.sciences.univ-nantes.fr/sites/genevieve_tulloue/Meca/Systemes/pendule_double.html



(a) with LED



(b) double pendulum

FIGURE 6.1 – A double pendulum. (a) a LED is attached to the last mass. (b) shows the parameters.

Double pendulum is not just funny. It is used in anti seismic architecture. Buildings are like the main pendulum, while a mass is attached to the fondation – as the second pendulum – to cancel building vibrations while earthquakes.

6.3 The system

The system is pretty complicated to expand. Nevertheless, previous equations should give enlightments on how the calculus is done. What you will actually have to know is the equations :

$$S = \begin{cases} \dot{x}_1 & = & x_2 \\ \dot{x}_2 & = & -\frac{y_2^2 m_2 L_2 \times \sin(x_1 - y_1) + m_2 L_1 x_2^2 \times \sin(x_1 - y_1) \times \cos(x_1 - y_1) + (m_1 + m_2) g \times \sin(x_1) - m_2 g \cos(x_1 - y_1) \times \sin(y_1)}{L_1 \times (m_1 + m_2 - m_2 \cos(x_1 - y_1))} \\ \dot{y}_1 & = & y_2 \\ \dot{y}_2 & = & -\frac{y_2^2 m_2 L_2 \times \sin(x_1 - y_1) + x_2^2 L_1 (m_1 + m_2) \times \tan(x_1 - y_1) + g (m_1 + m_2) \times \sin(x_1) - g (m_1 + m_2) \times \sin(y_1) \cos(x_1 - y_1)}{(m_2 L_2 \times \cos(x_1 - y_1) - (m_1 + m_2) L_2 \times \cos(x_1 - y_2))} \end{cases}$$

I know the equations are pretty ugly, but the results will be nice. Be carefull with the indices.

6.4 Let's work !

One can note that only boxed equations are really important for you.

6.4.1 Implementation of integrators

Use the code blocks project of last time, to complete the code to compute the pendulum evolution, with both the integrators described last week : Euler and Runge-Kutta 4.

6.4.2 Display

Complete the code to display one pendulum, then two pendulums at the same time. You can choose the starting coordinates.

6.4.3 Watch da chaos !

Launch the simulation with both pendulums, either with different integrators or slightly different initial conditions.

6.4.4 Return of Watch da chaos !

Store old coordinates, and print them while the pendulum(s) is moving.