Fys-Mek1110 – 2013 – Oblig 2

Motion capture

In this project we will study the motion of an object which is fitted with an accelerometer, and it is your task to figure out what physical phenomenon we are observing. You will need to find the motion from the acceleration of the object, and then interpret the motion in physical terms.

First, we will guide your intuition by starting with an introductory, analytical exercise.

A car rolling down a hill with an inclindation θ with the horizon experiences an acceleration $a = g\sin(\theta)$ along the surface of the hill. Here $g = 9.81$ m/s^2 is the acceleration of gravity. The car is released from rest at the time $t = t_0 = 0$ s.

(a) Sketch a motion diagram of the motion of the car.

(b) Find the position s and the velocity v of the car along the hill after a time t.

We will now introduce a reference system S oriented with the x-axis in the horizontal direction and the y-axis in the vertical direction – that is in the direction gravity is acting. Let us assume that the car starts in the position $x = 0$ m, $y = h$, where h is the height of the car, and that the car moves in the positive x-direction.

(c) Sketch the system and the coordinate system.

(d) Find the position $\vec{r}(t)$ and velocity $\vec{v}(t)$ of the car after a time t.

We will now address the motion captured by the accelerometer. The data-set `motion1.d` contains time (in s) and acceleration (in m/s^2) of an object, given as a sequence of points t_i, $a_{x,i}$ and $a_{y,i}$ taken at regular time intervals Δt.

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t0 ax0 ay0
t1 ax1 ay1
```

(e) Find the velocity $\vec{v}$ and position $\vec{r}$ of the motion using numerical methods. (For example using a simple Euler scheme for integration). Plot the path of the object. (Your answer should include a listing of the program used.)

(f) Can you give a physical interpretation of the motion, that is, can you describe a physical system that you would expect to behave in this manner?

(g) Where is the magnitude of the acceleration the maximum?

Another, similar, experiment was performed, giving the motion data in `motion2.d`.

(h) Find the position $\vec{r}_2$ of the motion, and plot it in the same plot as the motion in `motion1.d`.

(i) Can you give a physical interpretation of the motion?

(j) Where is the magnitude of the acceleration the maximum? How do you interpret this?

End of Oblig 2