TM Homework 1 BIG

Timur Islamov

Feb 2024

Link back to GitHub

1 Task 1

1.1 Task description

We have a mobile vehicle, which should survive after the track. We have some predefined trajectory, which is given in y(x) format. The goal is to pass this trajectory as fast as possible. But at the end of the path, there is a drop-off. It means that the vehicle should stop in the end. We have to establish some constraints, such as max tangent acceleration (max power on the motor), normal acceleration (road adhesion). How the vehicle should move (speed and acceleration) for solving such a task?

Report:

1. Vehicle simulation on the path. You should show $a, \vec{V}, \vec{a}, \vec{a_\tau}, \vec{a_n}$ on the simulation.

2. plots: $y(t), v(t), a_t(t), a_n(t), |t$ is time in seconds.

Parameters:

$y(x) = Ax * ln(\frac{x}{B}), where A = 3, B = 5, xis[0...4]$

$a_{t_{max}} = 2, a_{n_{max}} = 3, v_{max} = 3$

1.2 Solution

For more details see the .ipynb file in the folder.

Link to SIMULATION

Simulation Methodology

To simulate the vehicle's movement, we employ principles of theoretical mechanics. We discretize the trajectory and iteratively update the vehicle's position and velocity while considering acceleration constraints.

Acceleration Calculation

We calculate the tangential and normal accelerations based on the vehicle's velocity and trajectory curvature.

The tangential acceleration (a_t) is given by:

$$a_t = \frac{dV}{dt} \cdot \vec{V}$$

where V is the velocity vector and $\vec{V}$ is the unit vector in the direction of velocity.

The normal acceleration (a_n) is given by the second derivative of the trajectory with respect to x:

$$a_n = \frac{d^2y}{dx^2}$$

Simulation Loop

We iterate over discrete time steps, updating the vehicle's position and velocity. At each step, we ensure that acceleration values do not exceed predefined constraints.

The update equations are as follows:

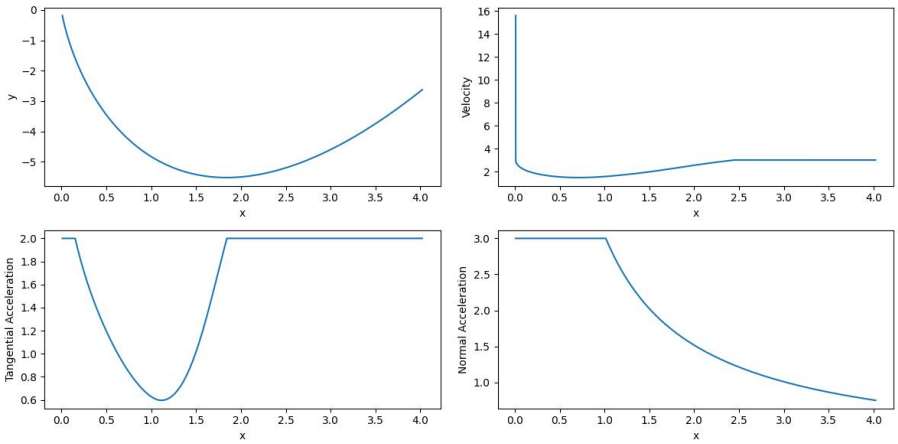
$$x_{n+1} = x_n + V_n \cdot \Delta t$$

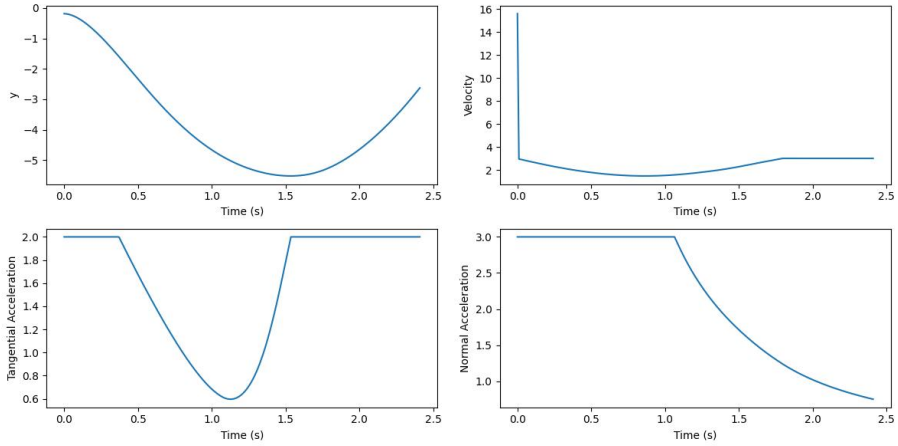
$$V_{n+1} = V_n + a_n \cdot \Delta t$$

where x is the position vector, V is the velocity vector, a is the acceleration vector, and Δt is the time step.

1.3 Plots

There could be some inaccuracies...





1.4 Answers

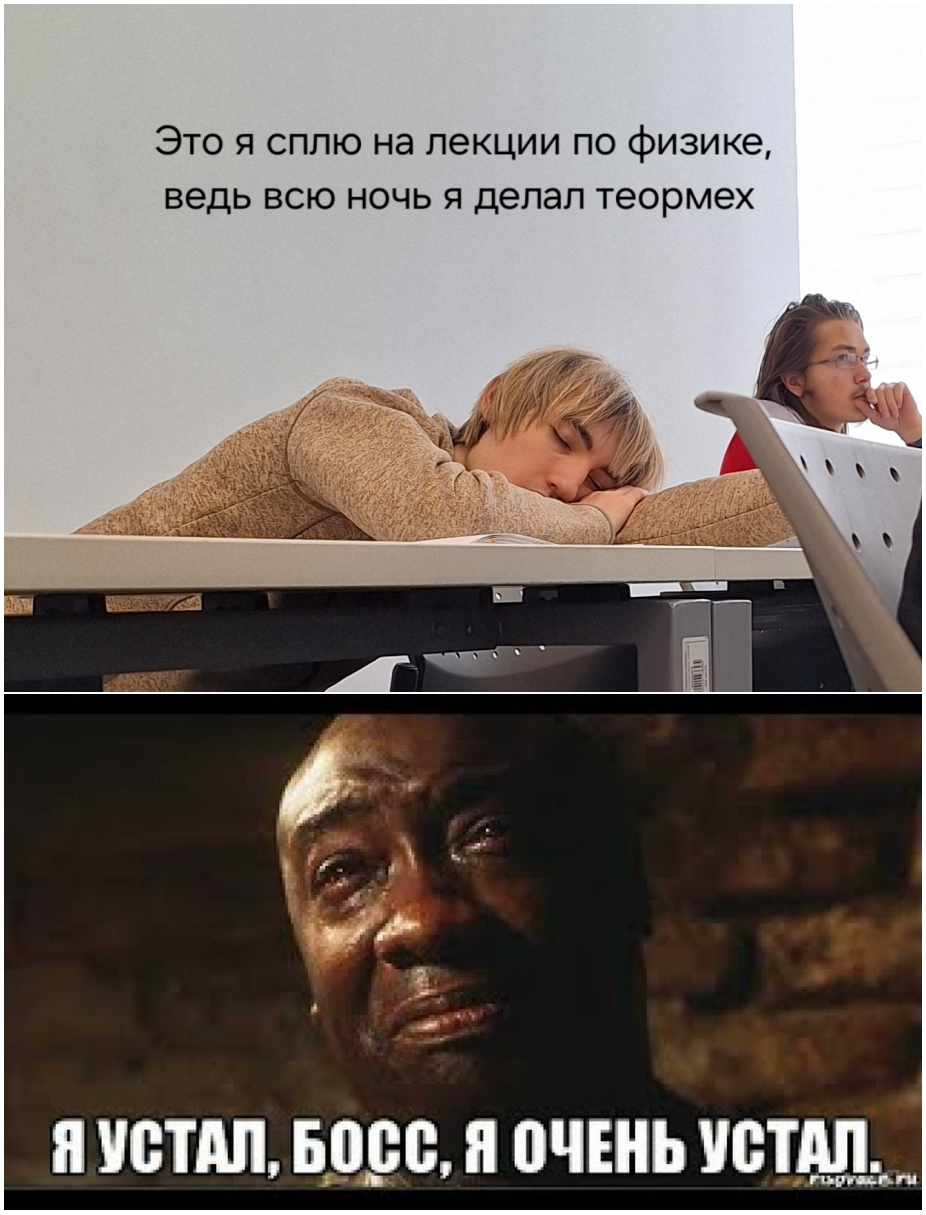
HIGHLIGHTED ANSWERS ARE HERE

Total time t is about 24.1 seconds. (See the .ipynb file)

$$a_t = \frac{dV}{dt} \cdot \vec{V}$$

$$a_n = \frac{d^2y}{dx^2}$$

2 MEME


Это я сплю на лекции по физике,
ведь всю ночь я делал теормех
Я УСТАЛ, БОСС, Я ОЧЕНЬ УСТАЛ.