PROJECT:INITIAL PLAN

Numerical Algorithms

Analysing Cart Pole Swing up (Z6)

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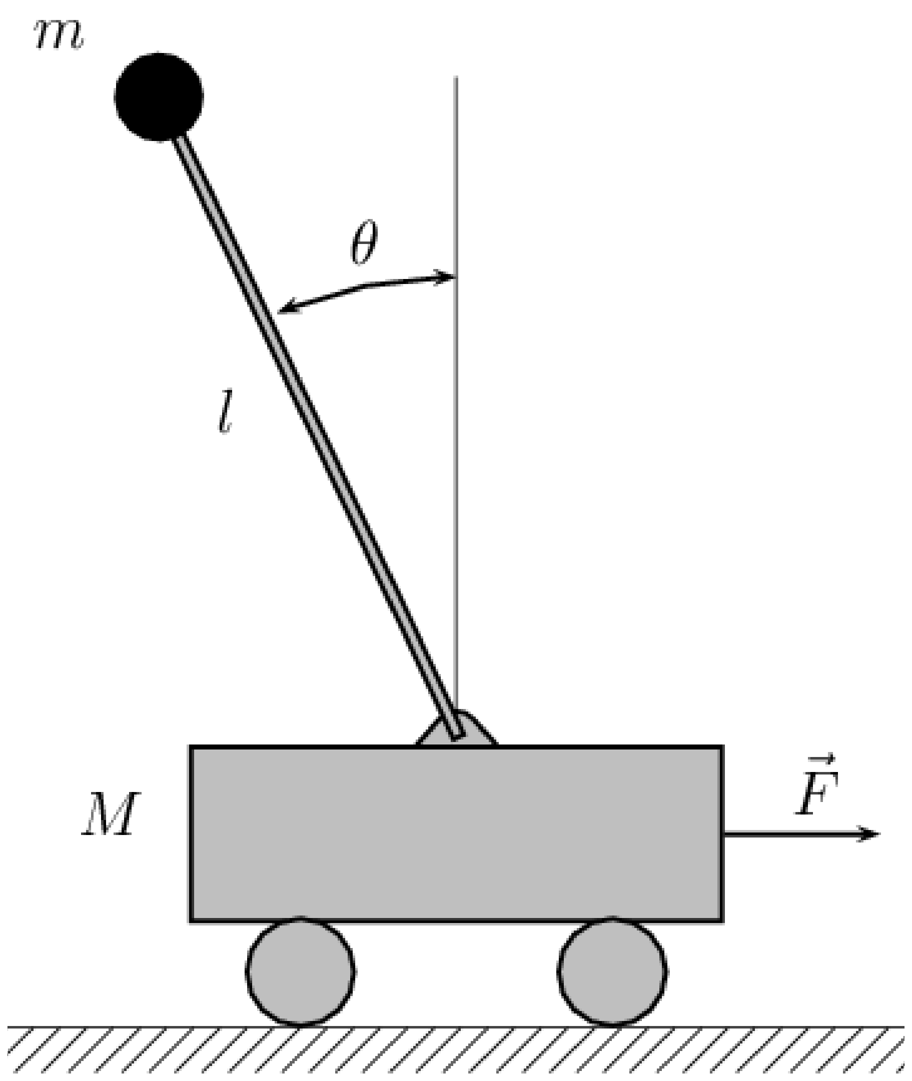
Problem Statement

The cart-pole system comprises a cart that travels along a horizontal track and a pendulum that hangs freely from the cart. There is a motor that drives the cart forward and backward along the track. It is possible to move the cart in such a way that the pendulum, initially hanging below the cart at rest, is swung up to a point of inverted balance above the cart. The problem is to numerically compute the minimum-force trajectory to perform this so-called "swing-up" maneuver.



Problem approach

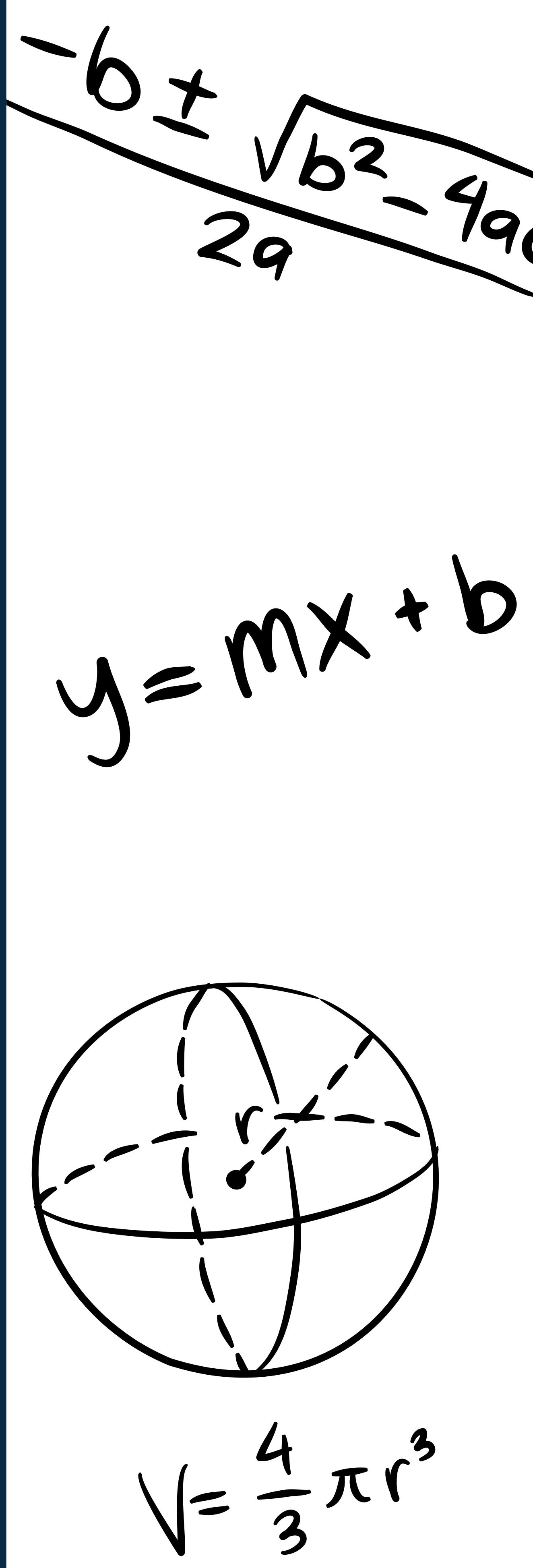
Objective function: the integral of the actuator-effort (control) squared:

$$J = \int_0^T u^2(\tau)\, d\tau.$$

Obtain differential equations for the position of the cart q1, the angle of the pole q2, and the control force is given by u.

Set boundary constraints and state and control bounds.

The Goal is to minimize J over all possible functions of u(t) satisfying the boundary constraints.



Problem approach

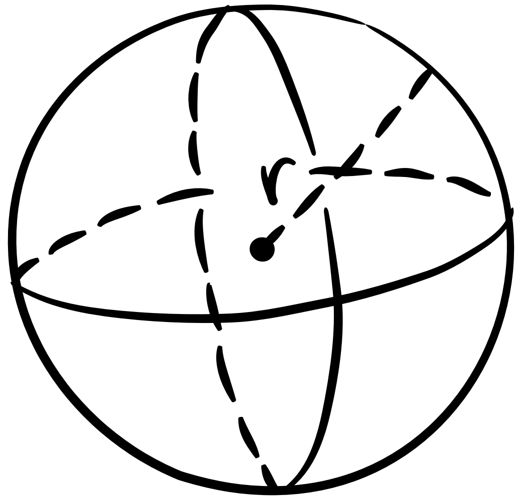
Initialise the states of the cart-pole.

Use trapezoidal collocation to add the extra conditions and model the problem as a non-linear program.

Alternatively, Hermite–Simpson Collocation can be used to model it as a quadratic instead of linear.

$$\frac{-b \pm \sqrt{b^2 - 4a}}{2a}$$

$$y = mx + b$$

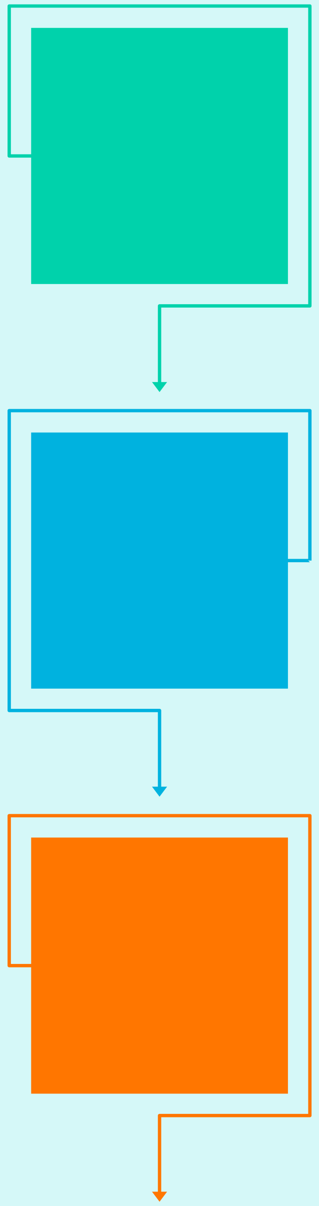


$$V = \frac{4}{3}\pi r^3$$

Problem approach

Results: Run the MATLAB code to show the trajectories obtained by the above collocation methods.

Test the stability of the algorithm by introducing perturbations in the simulation.



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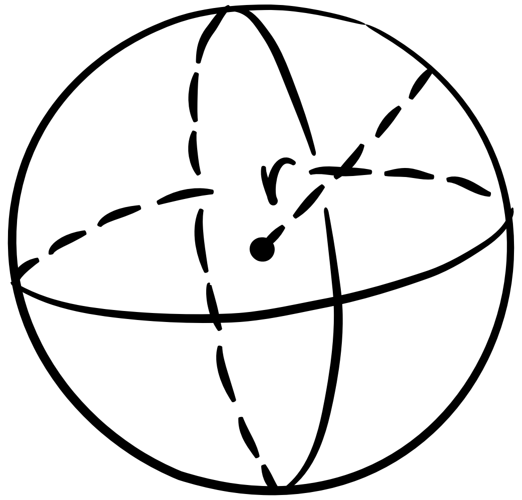

$$V = \frac{4}{3}\pi r^3$$

Thank You