Develop a vehicle dynamics model for Cruise control using M-script

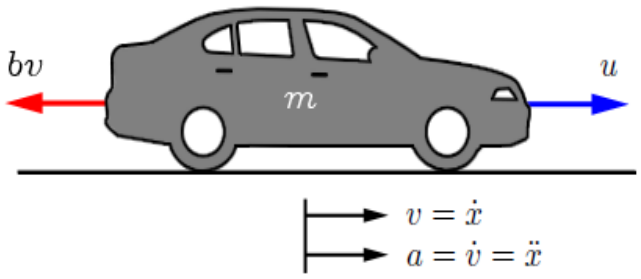
Introduction

The idea here is to design a model and PID controller for a vehicle to maintain constant speed i.e., automatic cruise control. The controller measures the vehicle speed and compares with the desired reference speed and automatically adjust the throttle body to maintain the constant speed.

Project Description:

The above-mentioned project is divided into two sub-sections one is deriving the mathematical model and transfer function of the vehicle and other is designing a PID controller. Here first, we will analyse the mathematical model and find the differential equation to derive transfer function of the vehicle.

- In order to model vehicle dynamics, we draw a free body diagram to the vehicle.
- The vehicle of mass m is acted upon by a control force u. The force u represents the force generated at the road/tire interface.
- The resistive forces bv due to rolling resistance and wind drag, are changing in a linear form with the velocity and act in an opposite direction to the vehicle.



The parameters and the respective values are given below:

- Input: Step as speed (r),
- Model Output: Speed (V).
- The physical parameters for our example are:

- M: mass of the vehicle 1000 kg
- b: vehicle viscous friction constant 50 Nms
- r: step input 10 m/s
- K_p: P controller gain 1000, 800
- K_i: I controller gain 40

Mathematical model of D.C motor:

- By applying newton's second law of motion:

$$m\ddot{x} = u - bv$$

- Getting the transfer function as before:

$$mSV(s) = U(s) - bV(s)$$

- Getting the output/input

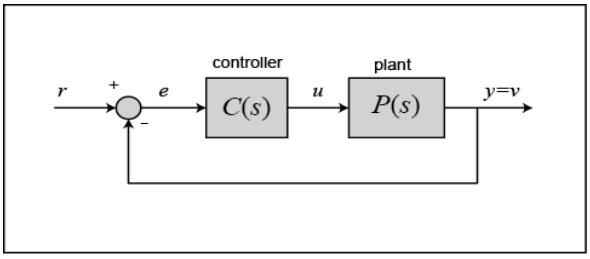
$$(mS + b)V(s) = U(s)$$

- Therefore, the Plant P(s):

$$V(s)/U(s) = 1/(mS + b)$$

PID controller:

- Develop the PID or P controller to control the speed of the vehicle.



$$C(s) = K_p + \frac{K_i}{s} + K_d s = \frac{K_d s^2 + K_p s + K_i}{s}$$

- Write a program to run the vehicle model with PID controller using M-script, define all the required parameters of the vehicle.

Conclusion:

As per the required specification I have written the program in M-script for speed control of the vehicle i.e., cruise control and also developed the PID controller. Finally, the vehicle dynamic model and the PID controller was tested and it runs successfully.