Modelling and control summaries

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MATLAB GUIs – cruise control

CONTEXT: A cruise control law needs to maintain the speed of a car notwithstanding changes in the slope of the road, car mass and engine power.

A simplified model of the speed of a car mass M is a mass-damper system; this assumes that resistance to motion Bv is proportional to speed v. Moreover, the slope of the road θ will affect acceleration through gravity *g* so a simple model is given as:

$$M\frac{dv}{dt} + Bv = Kf - Mg\sin\theta; \quad 0 \le f \le 1$$

For simplicity we use a normalised engine force on the road of f, so that more powerful engines have a larger K.

For simplicity, we assume the cruise control law selects f rather than fuel flow. The value is selected by a PI compensator so:

$$f = K_p(r - v) + K_i\int_0^t (r - v)dt$$

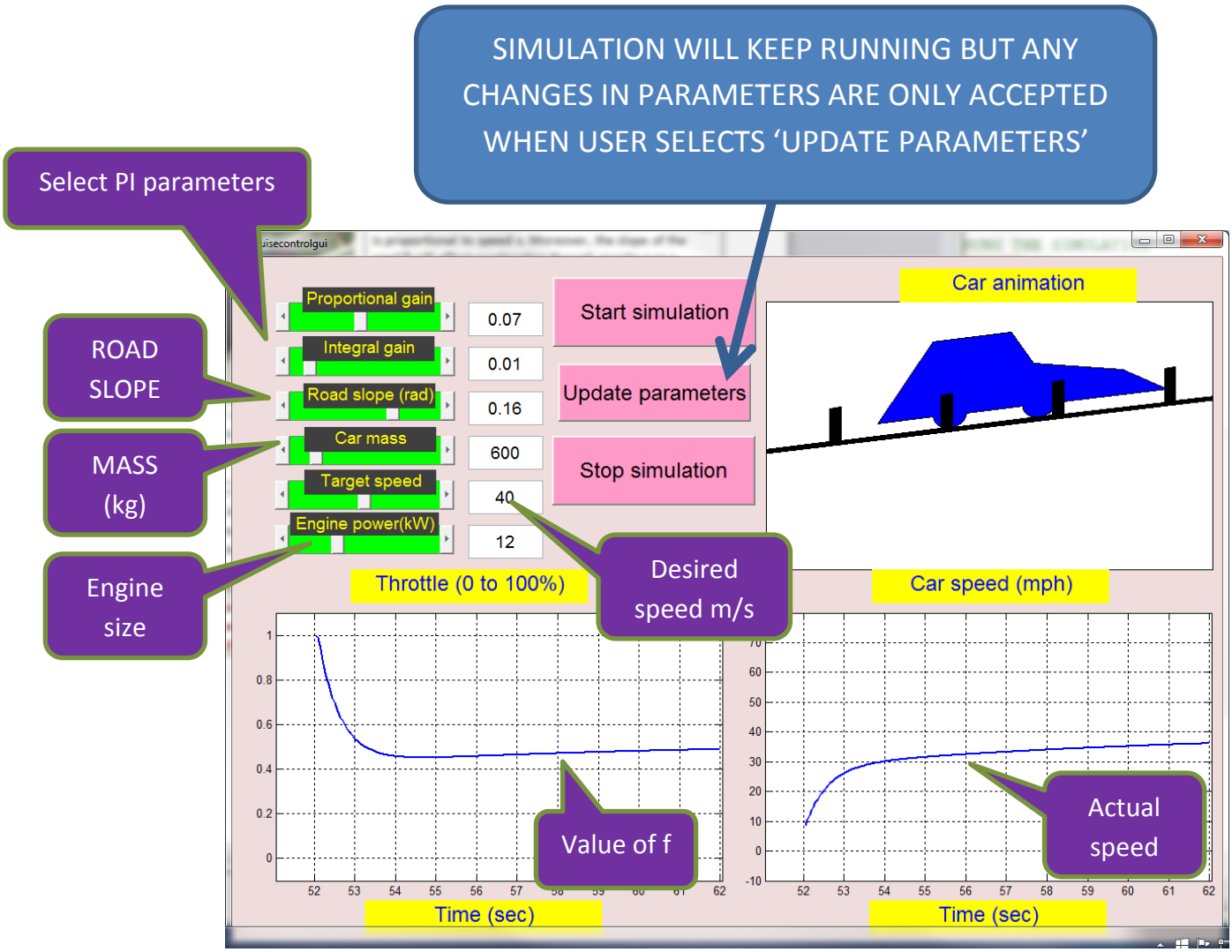
The GUI allows the user to investigate the impact of changes to a number of parameters:

1. Simple changes in the PI parameters.
2. Changes in car mass (for example with a fixed engine size).
3. Changes in engine (essentially K) with a fixed car mass.
4. The impact of changes in slope on behaviour.

All the parameters are listed in the GUI except for B which is 300. Mass is in kg.

ILLUSTRATIONS – the simulation runs fast compared to real time and students will see the car moving faster and slower relative to the background as well as going up or down.

FILENAMES are cruisecontrolgui.p, crusiecontrolgui.fig


SIMULATION WILL KEEP RUNNING BUT ANY CHANGES IN PARAMETERS ARE ONLY ACCEPTED WHEN USER SELECTS 'UPDATE PARAMETERS'
Select PI parameters
ROAD SLOPE
MASS (kg)
Engine size
Desired speed m/s
Value of f
Actual speed
Proportional gain
0.07
Integral gain
0.01
Road slope (rad)
0.16
Car mass
600
Target speed
40
Engine power(kW)
12
Start simulation
Update parameters
Stop simulation
Car animation
Throttle (0 to 100%)
Car speed (mph)
Time (sec)
Time (sec)