Vehicle Dynamics Identification and a Race Strategy for the Aeolus Wind Powered Vehicle

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Introduction

Racing Aeolus is an International competition which aims to aid in the development of wind energy technology through a drag race where many universities take part.

This project investigates the vehicle dynamics of the Bristol entry to the Aeolus competition and the power required to run particular race strategies.

Methods used included testing and data analysis by mathematical or graphical comparisons performed in MATLAB.

Vehicle Dynamics

The vehicle dynamics (Fig. 3) was modelled as:

$$F = -F_{AR} - F_{RR} - F_B - F_G + F_W$$

$$m\frac{dv}{dt} = -\frac{1}{2}\rho A C_d u^2 - C_{rr} m g - 1.3R_T - mgsin(\theta) + \frac{T_w}{r}$$

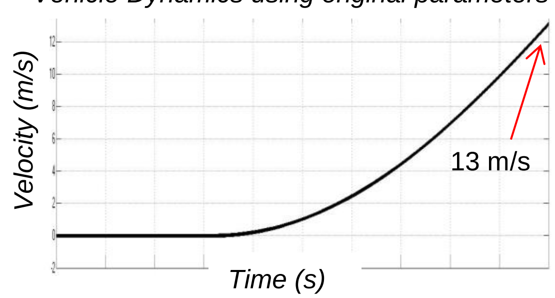
The rotor dynamics were not investigated in this report as the primary focus was identifying the rolling and air resistance coefficients.

Achieved through least squares fitting:

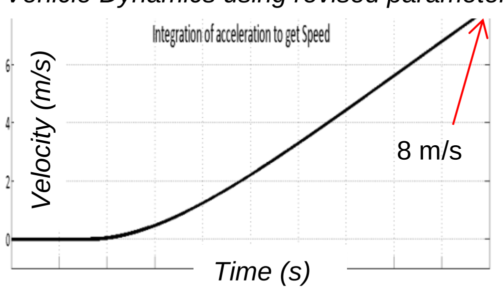
$$x = (A^T A)^{-1} A^T B$$

where x contained the unknown parameters, A contained the known parameters and B the known solutions.

Vehicle Dynamics using original parameters



Vehicle Dynamics using revised parameters



Power Electronics

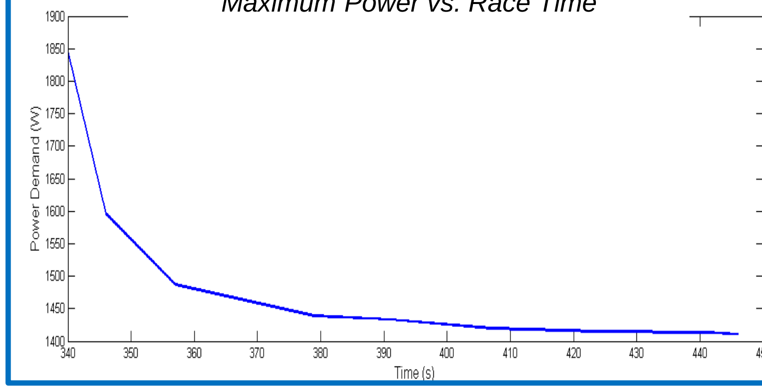
The electrical power equations were verified using results from testing at Membury airfield and dynamometer tests in the dynamics laboratory.

Resulted in a power demand model of:

$$P = \frac{2T_w}{\sqrt{3}K_e}\left[\frac{2T_w}{\sqrt{3}K_e}(23\omega_m L_m + R_m) + K_e\omega_m\right]$$

where m are subscripts for motor. The vehicle dynamics are incorporated through the wheel torque.

Maximum Power vs. Race Time



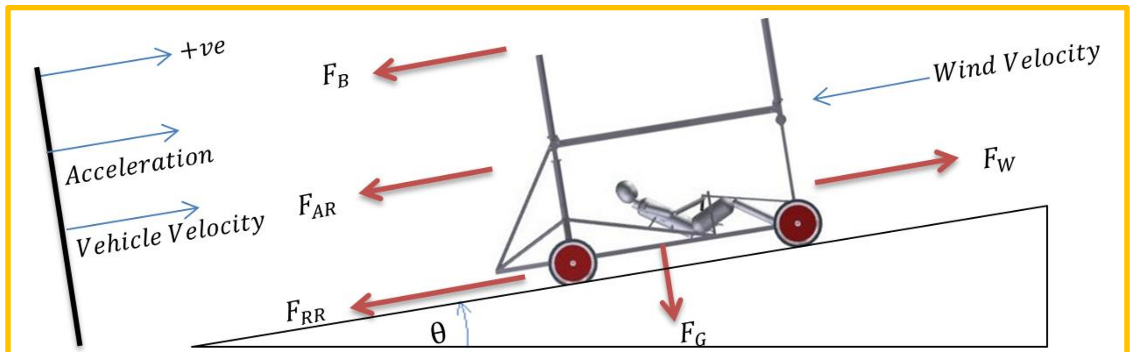


Figure 3: Vehicle Dynamics sign convention.

Conclusions

Critical Power range between 1.4kW and 1.5kW.

Suggests an energy storage device should be implemented.

Future work is needed to fully verify vehicle dynamics equation.