ME131 Lab 4 Deliverables
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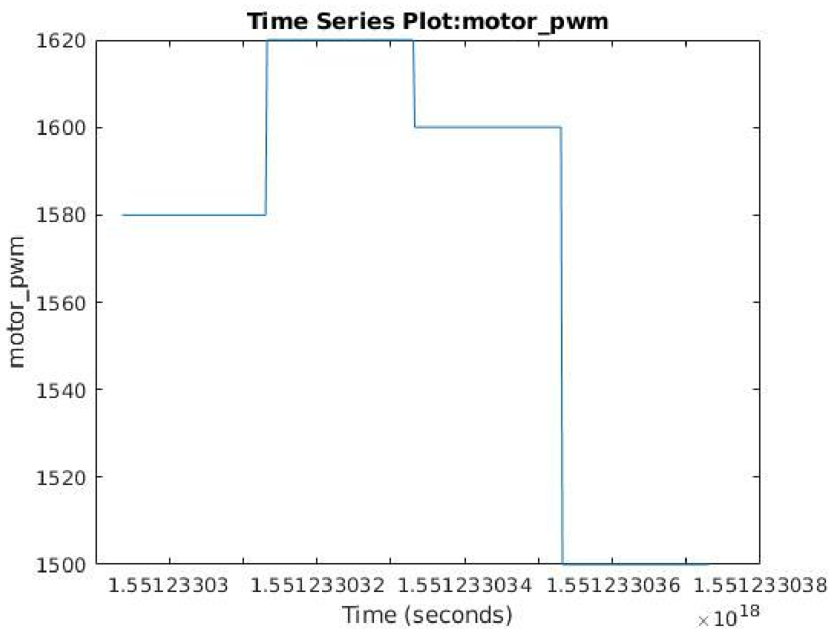
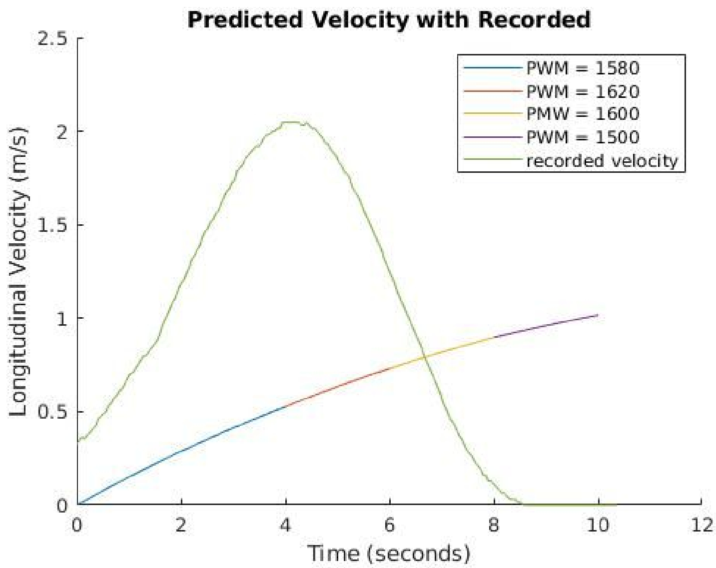
1.1
The transfer function for the acceleration is obtained from a linear regression of test data using the least squares method. Code for obtaining these plots and models is available at github.com/treyfortmuller/me131

$$G_{pwm} \rightarrow v(s) = \frac{-0.0943}{s - 0.0001}$$

1.2
Plot of PWM vs. Time (shown in UNIX time, i.e. nanoseconds since 1/1/1970)



Plot comparing recorded velocity data (extracted from a numerical differentiation of encoder data) with the prediction from our transfer function



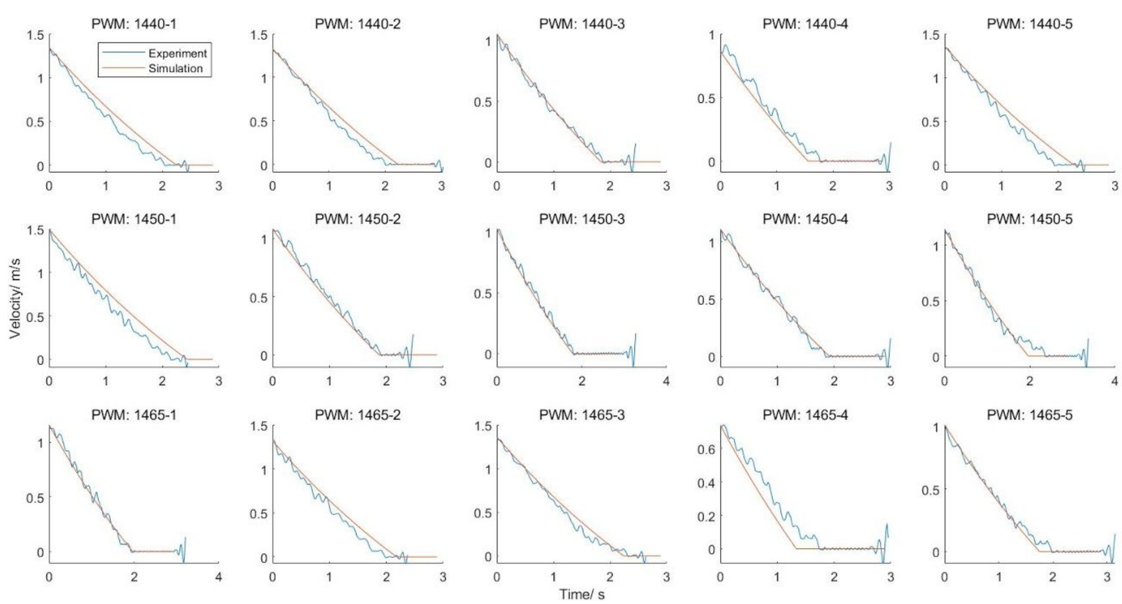
The model includes no dissipative effects, so the vehicle continues to accelerate even after the motor supplies no torque.

1.3

When braking, the transfer function is:

$$G_{pwm} \rightarrow v(s) = \frac{-0.0003275}{s + 0.2018}$$

1.4



This plot presents the smoothed velocity data and simulation result after braking PWM is applied.

1.5

From the kinematic model presented in Lab2 we have

$$L : \text{wheel base length}$$
$$\dot{\psi} : \text{yaw rate}$$
$$v : \text{vehicle speed}$$
$$\delta_f : \text{steering angle}$$

$$\dot{\psi} = \frac{2v}{L}\sin[\tan^{-1}(\frac{1}{2}\tan(\delta_f))]$$

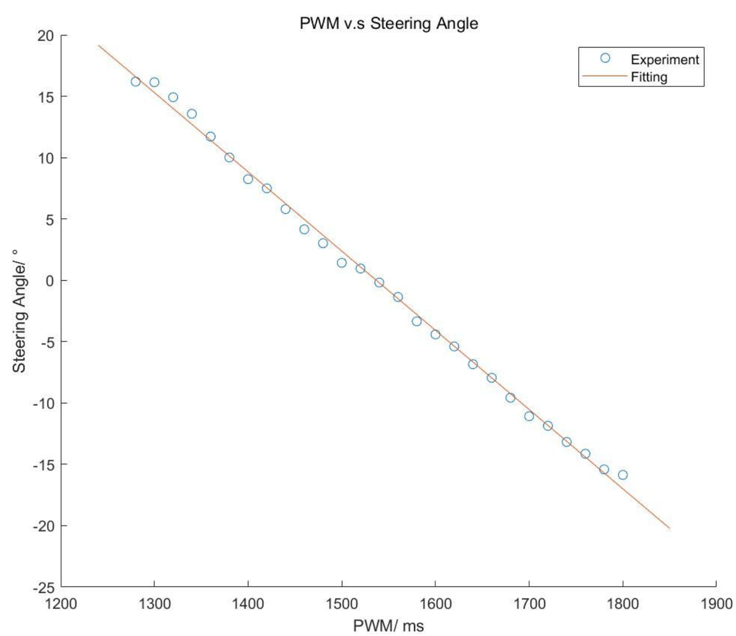
$$\sin^{-1}(\frac{L\dot{\psi}}{2v}) = \tan^{-1}(\frac{1}{2}\tan(\delta_f))$$

$$2\tan(\sin^{-1}(\frac{L\dot{\psi}}{2v})) = \tan(\delta_f)$$

$$\delta_f = \tan^{-1}[2\tan(\sin^{-1}(\frac{L\dot{\psi}}{2v}))]$$

So we have the steering angle as a function of the vehicle's longitudinal speed, wheelbase, and yaw rate.

1.6



The best fit line is:

$$\delta_f = \frac{180(-0.001127\,PWM + 1.732)}{\pi}$$