Balance-assist bicycle weave mode experiments

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Introduction

Research into the balance-assist bicycle is done with a model of a bicycle. The parameters of this model are for a different bicycle than the balance-assist bicycle. It is unknown how well the model represents the balance-assist bicycle. It is important for the balance-assist bicycle to be properly modelled, because the controller is designed based on the (thus far inaccurate) model. If the model is not representative of the balance-assist bicycle, the designed controller could be invalid.

The goal of this experiment is to identify the actual weave mode of the balance-assist bicycle.

Methods

The weave mode will be identified by manually perturbing the bicycle at the seat post, and measuring the consequent roll rate. The weave mode can be found be fitting a decaying oscillation to this data. The function that is fitted is defined by Kooijman et al. [REFERENCE] and can be seen in equation 1. This has been done with the balance assist system on with a gain of -8 and -6 at speeds of 6, 8, 10, 12, 14, 16 and 18 km/h. An example of such a fit can be seen in figure 1.

$$c_1 + e^{dt} * (c_2 \cos(\omega t) + c_3 \sin(\omega t)) \tag{1}$$

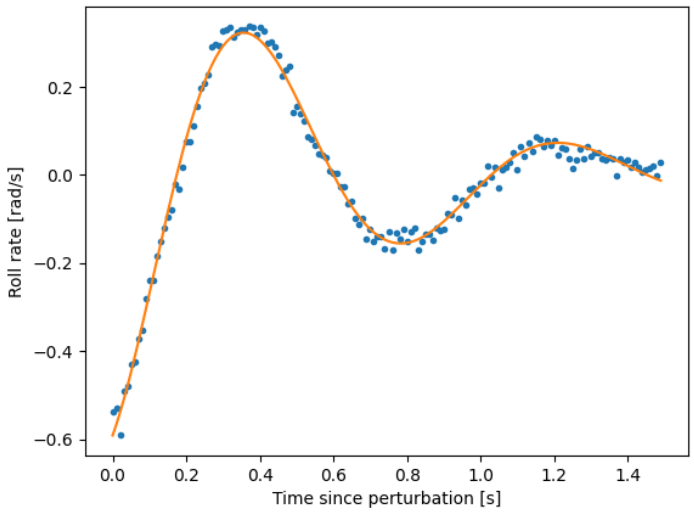

Figure 1: Example of a fit of a decaying oscillation to roll rate data.

Results

Measured eigenvalues for a gain of -6 can be seen in figure 2 and the results for a gain of -8 can be seen in figure 3.

Discussion

From the results in figures 2 and 3 it can be seen that the real part of the eigenvalues (black dots) are approximately on the theoretical eigenvalues of the Batavus Browser bicycle. The imaginary part, however, is quite different from the theoretical eigenvalues, especially for the gain of -6.

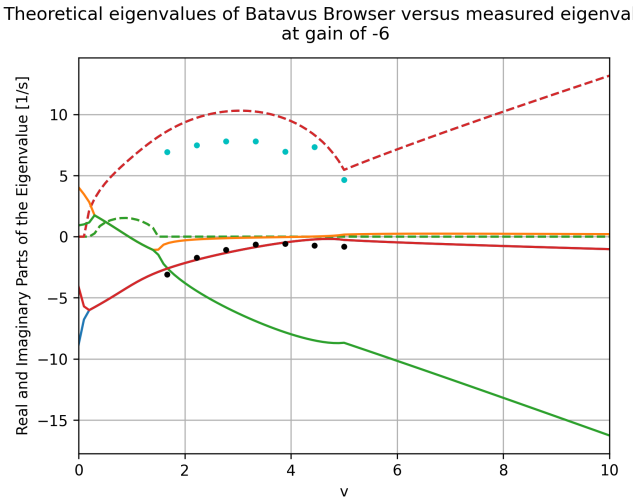

Figure 2: Theoretical eigenvalues of Batavus Browser versus measured eigenvalues at gain of -6. The real part of the measured eigenvalues is displayed in black, the imaginary part is displayed in cyan.

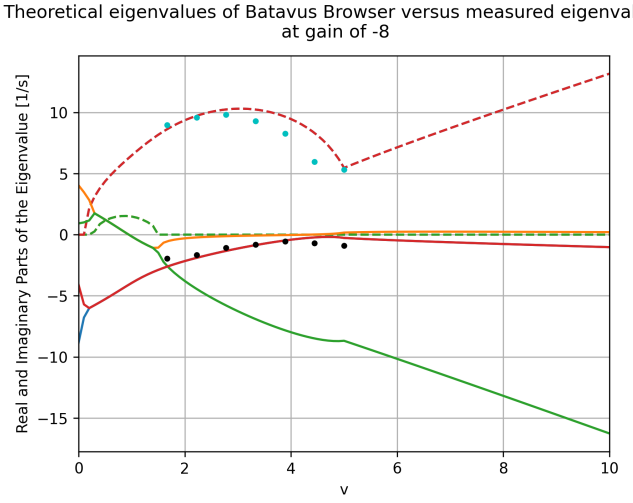

Figure 3: Theoretical eigenvalues of Batavus Browser versus measured eigenvalues at gain of -8. The real part of the measured eigenvalues is displayed in black, the imaginary part is displayed in cyan.