Discussion on: “Experimental Identification of Engine-to-Slip Dynamics for Traction Control Applications in a Sport Motorbike”

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Motorbikes represent a class of the most difficult systems to be controlled. Their instability in nature, intensively coupled dynamics among different motion axes, and highly nonlinear constraints imposed on multiple variables substantially challenge the control system designs. They are the systems that no single-equation can describe precisely.

In the aforementioned paper, a particular problem of the motorbikes, namely engine-to-slip in longitudinal motion, is studied. Aimed at achieving the maximum possible acceleration, this research takes the throttle position and spark-advance as the two control variables to study their impacts on the output variable namely the longitudinal slip.

The entire research is based on the physically measured input–output data, rather than on the analytical multi-body dynamics. Thus, an identification process aimed at obtaining the input–output relationships is necessarily needed. As expected, transfer functions are used to identify the system dynamics and the results are validated in both frequency and time domains.

Although being very original for this interesting problem, this research leaves some questions to be answered in the future. As mentioned early, motorbikes are multivariable systems. The input–output relationships are very dynamic, nonlinear, and complex. They usually involve many secondary input variables such as the quality of the road surface and the tire tread. Although it is convincible that the engine throttle is one of the primary input variables, the impacts of other secondary variables remain to be exploited. In this paper, these secondary factors were kept constant in order to emphasize the primary input–output relations linking the throttle position and spark-advance to the longitudinal slip. A natural question, therefore, is “do the conclusions drawn in this paper are still valid for different road conditions and different tire treads?” Particularly, consider the fact that the studied system is nonlinear in natural, which most likely prevents the linear-system-based superposition principle from being directly applied in the first place.

Attention need also to be paid to the use of transfer functions. The original concept of the transfer functions in classical text books is based on an assumption that the targeted system is linear. At a given frequency, the input and output sinusoidal signals with a linear system keep the same frequency, but with different amplitudes and phases. The relations between the input–output amplitudes and phases are characterized by a complex number. Besides being already quite challenging to extend the concept of transfer functions to nonlinear systems, this paper extend the concept of transfer functions with an even more broad sense – to deal with harmonic outputs, allowing the output signal to have a different frequency from the input signal. As a result, the meaning of the transfer function is no longer a complex number at a given frequency, as the phase of the output signal varies consistently versus the phase of the input signal.

In summary, this is a very interesting paper focused on a very interesting practical problem. In the future, it is expecting that more rigorous theoretical backgrounds are to be laid and more remaining questions are to be answered.

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