Bicycles, Motorcycles and Feedback

The design and development of modern road vehicles calls for a combination of disparate engineering disciplines. If customer requirements are to be met in a cost-effective manner, modern computer modelling, design and manufacturing processes must be used. Following a broad introduction, the lecture will introduce the idea of using ‘feedback theory’ to improve the dynamic behaviour of high-performance motorcycles. The ‘controller’ is a network of passive mechanical components, and is seen as possible replacements for the conventional steering damper. The design and synthesis of these compensation systems make use of an analogy between passive electrical and mechanical networks. This analogy is reviewed alongside the links between passivity, positive reality and network synthesis. Compensator design methods that are based on classical Bode-Nyquist frequency-response ideas will be presented. Initial designs are subsequently optimized using a sequential quadratic programming algorithm. A number of simple networks are investigated and compared with a general bi-quadratic positive real function. The results show that, compared with a conventional steering damper, it is possible to obtain significant improvements in the dynamic properties of the primary oscillatory modes, known as ‘wobble’ and ‘weave’.

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