ON SEMI-ACTIVE DAMPING CONTROL OF SUSPENSION SYSTEMS

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Abstract: In this paper, a quarter-car model with semi-active suspension system is considered and four different control approaches: skyhook control, groundhook control, hybrid control, Rakheja-Sankar (R-S) control method, are applied to eliminate the undesirable effects of the road excitation.
In the previous generation of vehicles, the suspension systems were designed and manufactured with fixed properties, passive suspension. Unfortunately, such systems do not provide an optimal ride or an acceptable level of stability under all circumstances. For several decades, controllable suspension systems including active and semi-active systems have been developed to concurrently improve the ride comfort, road handling and stability of terrain vehicles. However, active suspension mechanisms were soon abandoned by vehicle manufacturers due to high cost, implementation complexities and also failure mode safety issues. Semi-active suspension systems are supplied only by a low power electrical signal and exhibit high performance vibration isolation. Diverse methods controllers have been employed for years to design suspension. Linear controllers are normally based on optimal control (LQR/LQG), the skyhook principle or robust control (H_∞ and μ-synthesis).
Pure skyhook control is only optimal in the sense of minimising vibration transmission to the sprung body. It has the disadvantage of not considering rattle space and simulating a situation where there is no wheel damping, which leads to a massive wheel-hop resonance when compared to a traditional passive damping. Therefore, variations of the skyhook damper controller are necessary. The analogue principle may be applied to the control of the non-suspended mass. Connecting the wheel to a skyhook is termed as 'groundhook'. It obviously presents the opposite problem, as adverse effects on body-resonance control arise. A hybrid method combining aspects of groundhook and skyhook was discussed as a potential alternative to get a more acceptable compromise for a wider range of applications. Given that the use of the relative displacement of the wheel with respect to the road profile for control purposes is not feasible in practice, the control force is usually built as a linear combination of skyhook and passive components, which takes the name of modified skyhook damping (MSD).

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