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Hysteresis modeling and precise control of magnetorheological semi-active system

Precise hysteresis description and efficient control of smart materials and structures are the only way to the applications. Magnetorheological semi-active seat suspension system for an extreme application - mine-resistant ambush-protected vehicles, is taken as an example to show: (i) how hysteretic nonlinearity is efficiently modeled and (ii) how precise control is realized.

The impact caused by the detonation of landmines and improvised explosive devices may lead to spine fracture and injury of the seated occupants on mine-resistant ambush-protected vehicles. The vibration transmitted from the uneven road surface is another factor affecting ride comfort/health, on the other hand. Aiming at minimizing the injury to spine and "discomfort" due to the shock and vibration from the terrain or blast, a magnetorheological energy absorber-based semi-active seat suspension system for both shock and vibration mitigation is investigated. A resistor-capacitor operator, summarized from the electric circuit characteristics, is proposed to model the rate-independent memory effect of the magnetorheological energy absorber. A concept of integrated hybrid controller combining strategies for shock and vibration control is proposed for the specific application. The hybrid controller employs the skyhook control strategy to achieve vibration control and the "soft-landing" control strategy to achieve shock control, and it switches between the two control strategies according to the system dynamic states. As a result, precise output of the desired damping force of the hybrid controller is realized by the magnetorheological energy absorber from numerical simulation and experimental tests.

Biography

Xian-Xu 'Frank' Bai received his Ph.D. degree in Instrument Science and Technology from Chongqing University in 2013. He joined Hefei University of Technology in 2013 and founded Laboratory for Adaptive Structures and Intelligent Systems (LASIS) in 2016. His research interests are focused in two areas. (i) Design, optimization, dynamics, and control of smart structures based on smart materials, including magnetorheological fluids/elastomers and magnetostrictive materials, applied to automotive and aerospace systems, and (ii) New mechatronics-based vehicle dynamics and control in emphasis on intelligent/unmanned vehicles. He has authored over 50 international journal and conference articles. He is an inventor on 16 issued Chinese patents and 2 PCT US patents (pending). Currently, he serves as an Associate Editor of Journal of Intelligent Material Systems and Structures. He is a Committee Member of Adaptive Structures and Materials System Branch of Aerospace Division of ASME. He is a peer reviewer of over 30 international journals. He is a member of ASME, SAE-China and IEEE.

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